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No. 38

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CONSTITUTION OF THE CHINA SCIENTIFIC, TECHNOLOGICAL SOCIETY

Beijing RENMIN RIBAO in Chinese 28 Mar 80 p 2

[Text] **Chapter I General Rules**

Article 1. The Society's official name is The China Scientific and Technological Society, abbreviated Zhongguo Kexie [CSTS].

Article 2. The CSTS brings together various mass organizations consisting of scientific and technical workers under the leadership of the Communist Party of China. Its purpose is to promote China's scientific and technological development and expansion in order to elevate the standards of the entire Chinese nation and to achieve a strong socialist state as soon as possible.

Article 3. The primary tasks of the CSTS are:

A. In the spirit of "let a hundred flowers bloom and a hundred schools of thought contend," to organize and support society members in the active promotion of academic exchanges and the compilation and publication of academic books and periodicals.

B. Based on the necessity to realize the four modernizations, to use every means to direct scientific and technological knowledge toward the broad cadres and masses; to develop movements of scientific and technical education for youth; and to coordinate with concerned organs to actively develop technical exchanges and experiments of a mass nature.

C. To mobilize society members and scientific and technical workers to advance proposals for scientific and technological projects and other areas of development; to play an advisory role for goernmental organs and enterprise units with scientific and technological problems; and to accept related tasks entrusted to it by governmental organs and enterprises.

D. To conduct the popularization of all scientific and technological projects as well as other undertakings and activities in the service of society members and scientific and technical workers.

E. To regularly report to party and governmental organs the opinions of the Society members and scientific and technical workers.

F. To strengthen and coordinate the relationships among the various subordinate scientific and technical organizations to strengthen the bond between the natural sciences and the social sciences.

G. To actively promote international academic exchanges and develop friendly relations with foreign scientific and technical organizations and workers.

Chapter II Society Membership

Article 4. Any mass organization (including academic associations, societies, research institutes and organizations for the popularization of science) of scientific and technical workers which agree to comply with the constitution of the Society may become Society members by applying to and receiving approval from the Standing Committee. Society members may [also] declare their withdrawal from the Society.

Article 5. Rights and Obligations of Society Members

Rights:

A. May be deputed to attend Society conferences and may vote and stand for election.

B. May voice criticism of and make suggestions to the Society.

C. To render to the Society necessary support and assistance in Society scientific and technical projects.

D. Shall have priority in attending all Society-sponsored functions.

Obligations:

A. To comply with the Society constitution and carry out decisions of the Society.

B. Complete Society tasks in a positive fashion.

D. Pay Society membership dues.

D. Submit to the Society at least one work report a year.

Chapter III National Organization

Article 6. The supreme authority for the Society is the National Congress and representatives are elected democratically. Congresses are held once every 5 years and must be convened on schedule unless there are unusual circumstances.

The responsibilities of the National Congress are as follows:

A. To discuss and decide upon the Society's work policy and tasks.

B. To hear and approve National Committee work reports.

C. To draft and amend the Society's constitution.

D. To elect new National Committees.

Article 7. When the Congress is not in session, the Society's supreme leadership organ is the National Committee. The quota of members for the National Committee is fixed by the National Congress. The National Committee elects one chairman, and a number of vice chairmen and standing members who make up the Standing Committee. The National Committee, the Standing Committee, the chairman and vice chairmen are all selected without regard to quota by means of secret ballot. The chairman and vice chairmen may not serve ordinarily for more than two consecutive terms. The National Committee conducts its activities on the basis of decisions made by the National Congress and the Society's constitution; it hears and approves work reports of the Standing Committee.

The National Committee is to be convened once a year and will begin on schedule unless there are unusual circumstances.

Article 8. The Standing Committtee is a permanent organization of the National Committee. When the National Committee is not in session, the Standing Committee takes charge of the work of the Society.

Article 9. The Standing Committee fixes the number of secretaries, who form a secretariat under the guidance of the Standing Committee, to manage routine affairs.

On the basis of work requirements, the Standing Committee will set up and popularize work committees, academic work committees, and international activities committees and their corresponding administrative bodies.

Chapter IV Local Scientific and Technical Societies

Article 10. Scientific and technical societies at the provincial, municipal, and autonomous region level and below are the various levels of the local organizations of the CSTS and are subordinate to the Society level immediately above.

Article 11. Mass organizations of scientific and technical society workers at the provincial, municipal and autonomous region level and below may apply for membership in corresponding Society [organizations].

Article 12. Society conferences at the provincial, municipal and autonomous region level and below are to be held every 3-5 years to select leadership organs. On the basis of work requirements and the expansion of activities, the various levels of the Society will provide the requisite administrative organs and specialized committees.

Article 13. The method of organization for the basic-level local scientific and technical societies (such as factories and communes) is drawn up on the basis of the actual situation at the provincial, municipal, and autonomous region level.

Chapter V Funds

Article 14. Sources of Society's Funds:

A. Funds allocated by the state;
B. Income from Society-operated enterprises and activities;
C. Unit or individual contributions;
D. Society dues.

Chapter VI Supplement

Article 15. This constitution has been approved by the National Congress.

Article 16. The scientific and technical societies of the provinces, municipalities and autonomous regions may determine the implementation of the details of this constitution; all mass organizations of scientific and technical workers may draft their own rules and regulations.

CSO: 4008

DEVELOPMENT, PROSPECTS OF MARINE GEOPHYSICAL EXPLORATION REVIEWED

Beijing DIQIUWULI XUEBAO [ACTA GEOPHYSICA SINICA] in Chinese Vol 22 No 4, Oct 79 pp 370-373

[Article by Liu Guangding [0491 0342 7844]: "Marine Geophysical Exploration in China and Its Prospects"]

[Text] Abstract

In celebration of the 30th anniversary of the founding of the People's Republic of China, the author briefly reviews the development of marine geophysical exploration in China and discusses its progress and prospects.

As we celebrate the 30th anniversary of the founding of the great People's Republic of China, the whole nation is united as one in an effort to realize the four modernizations. At this particular moment, it is of great significance to review the historical development of marine geophysical exploration in our country, discuss current work, and look at the prospects ahead.

(1)

The introduction and development of marine geophysical exploration in our country are inseparable from the leadership and concern of the Chinese Communist Party. Under this premise, land geophysical exploration is the basis of marine geophysical exploration.

Of strategic importance was the establishment of two geology colleges in Beijing and Changchun at the same time the Ministry of Geology was founded in 1972. Moreover, the setting up of departments of geophysical exploration as well as teaching and research sections helped to create conditions for training geophysical exploration technical cadres and developing the geophysical exploration enterprise. Today, the overwhelming majority of geophysical exploration personnel throughout the country who are actively working in the vast expanses of open country and seas are originally graduated from these two colleges; some of them are also graduates of the Chengdu Geological College which was subsequently established. Although this contingent has several thousand people whose professions are diversified in such areas as petroleum, metals, aerial and marine, their techniques still fall within the comprehensive application of seismic, gravitational, magnetic, electrical and radioactivity methods. Growing from strength to strength in practice, and striving to fulfill the goal of geological exploration of minerals, they have made contributions in such aspects as the application of theories, instrumentation, observation techniques and data interpretation. There is no comparison between this kind of contingent and the preliberation days when there were merely ten-odd people in the field.

Geophysical exploration is a frontier science between physics and geology; its realm covers a broad area, and high level of technology is involved. In order to solve various kinds of problems which occur in practice, it continuously absorbs new achievements in modern science and technology so as to enrich and develop itself. Under such circumstances, it is certainly no easy job to train geophysical exploration cadres, especially during the initial stage. The Geophysical Research Institute of the Chinese Academy of Sciences has made quite a few contributions towards the training of large numbers of geophysical exploration personnel within the shortest possible time, as well as supervising the exploration enterprise in New China.

China's marine geophysical exploration was initiated in 1958 when the Ministry of Geology, Ministry of Petroleum and the Institute of Oceanography of the Chinese Academy of Sciences jointly organized a marine seismic survey team in Qingdao which began to search for ways of using geophysical methods in marine exploration. In 1960, the Ministry of Geology set up the Fifth Geophysical Exploration Brigade in Tanggu, which began a series of seismic reflection and gravity survey projects in the Bohai Gulf region and conducted extensive positioning and sounding work in specific areas. In 1964, the Ministry of Geology centralized the Marine Geophysical Exploration Teaching and Research Department of the Beijing Geology College, the Marine Geology Department of the Changchun Geology College and the former Petroleum Geological Survey Team in Caidamu, and established the Marine Geology Research Institute in Nanjing which set marine geophysical exploration, subsea petroleum, intertidal fascia sedimentation and geomorphological survey and research work into full swing. Although this contingent of the Ministry of Geology had suffered from certain interruptions for a period of time, it has nonetheless succeeded in supplying the state with comprehensive marine geological and geophysical survey reports on the Bohai Gulf and the northern gulf region, as well as evaluations and charts on the long-term prospects of oil and gas, thus providing basic information for petroleum exploitation in these two sea areas. In addition, it has set up radiolocation systems in the Yellow Sea, East China Sea, and the sea region at the mouth of the Pearl River, and conducted many types of geological and geophysical surveys, such as seismic surveys, gravity surveys, depth probes, samplings, etc. The survey data has not only helped deepen our understanding of the geological structure and sediment distribution of the Chinese continental shelf, it has also played a tremendous role in the evaluation of the long range prospects of China's subsea oil and gas.

(2)

Throughout its 20 years of development from the very beginning to the present, China's marine geophysical exploration has always been strictly geared by the policy of self reliance; from instruments, methods and data gathering to data processing and interpretating, every single progress was made through probing step by step. Today, such equipments as nuclear precession magnetometers, subsea gravimeters and shipboard gravimeters, seismic combination airguns and constant buoyancy combination cables, etc. are being used in marine geophysical exploration; these results were all achieved under the guidance of the preceding spirit.

But it was also during those two decades when two major developments were made in foreign countries which greatly hastened the progress of marine geophysical exploration.

First came the broad application of digitization in geophysical exploration. Digital magnetic tapes are used in the data gathering stage of geophysical exploration and high speed electronic computers are used in data processing. It is most extensively applied in reflection shooting. Large volumes of data can be rapidly processed, optimum filters can be used to eliminate interruptions, thus enhancing the signal-noise ratio and resolution ability, and improving the quality of information. Moreover, it is possible to utilize the dynamic characteristics (wave form, amplitude, frequency, etc.) of seismic waves in obtaining the physical parameters of rock layers which can even lead to the immediate discovery of oil and gas deposits.

Next came the introduction of the plate tectonic hypothesis in the late 1960's which resulted from paleomagnetic research and marine geophysical surveys and was largely supported by the continental drift and seafloor expansion theory of the 1950's. Although there are quite a number of shortcomings in this hypothesis which need to be overcome through continuous efforts, its dynamic concept is basically correct and full if vitality. It can be used to interpret many geological phenomena which could not be explained with the static theory. It is especially useful for providing unified models for such problems as the development of oceanic basins, geological structures, distribution of oil and gas deposits, and the genesis of multimetal mineral beds.

Today, China's marine geophysical exploration is still concentrated within the vast expanse of Chinese territorial waters. But the China Sea, which borders the Pacific Ocean in the east, should be classified as an arc-rear basin or fringing sea behind the trench arc system; it is linked to the Indian Ocean by a vast deep-sea basin. There are quite a few important theoretical problems in this area which are worth investigating and studying. There are a lot of major prospects of practical value which urgently need to be explored and developed, e.g. placer deposits along the sea coasts, petroleum under the continental shelves, manganese modules in deep ocean beds, etc. Thus, the application of the plate tectonic hypothesis in the research on the formulation and evolution of China's seas has provided the theoretical basis for evaluating China's seafloor structure and subsea mineral resources, especially petroleum and gas, which is of tremendous importance. But, these essential tasks not only require extensive marine geophysical surveys on the structure of sedimentary layers, but also an appropriate amount of investigation and research on the structure of the earth crust. Real efforts must be spent on basic theoretical work.

At present, the digitization of China's marine geophysical exploration equipment is being gradually accomplished. A digital computer processing center is currently under construction, including both hardware and software. Thus, so as long as China's marine geophysical exploration projects are planned through the proper guidance of theoretical ideas, and coupled with comprehensive data interpretation and research, it is bound to contribute towards the four modernizations in the immediate future.

(3)

Marine geophysical exploration is based on the theory of seismic wave propagation. But from the very beginning, there have been two kinds of arguments concerning the propagation of seismic waves, i.e. kinematics and dynamics. So far, the results achieved in our country's application of seismic sounding are chiefly based on kinematics. At present, there is still a series of problems that need to be solved, such as the capturing of deep sounding reflections, the establishment of standard seismic positions, the identification of faults, the relations between seismic positions and geological positions, etc. Thus, it is necessary to deploy appropriate lines and grids, select effective methods, use instruments properly, and check geophysical exploration results against drilling data. It should be pointed out that velocity is the only parameter which kinematic seismology can correlate with the properties of rock formations; but the accuracy of velocity values is somewhat limited in the reflection method.

Through the application of the dynamic characteristics of seismic waves, it is possible to expand the application range of seismic exploration and enhance its capacity in solving practical problems. This is especially true in light of the close relationship between the characteristics of dynamics and the physical properties of rock formations; it is of great geological significance to make a comprehensive study of their characteristics. In recent years, the discovery of lithologic deposits, especially the successful application of the flash dot technique which enables direct discovery of subbottom natural gas, resulted from the application of reflected wave dynamics. In the course of subsea petroleum exploration through the application of marine geophysical methods, it was not only necessary to continue the previous surveys on the structures of various parts in the basin and thus provide boring positions for drilling operations, it was also necessary to open up new paths by using the dynamic characteristics of reflected seismic waves in prospecting for lithologic deposits and by using the flash dot technique in oil and gas exploration. Here the Changjiang Delta and Pearl River Delta should be given first consideration.

(4)

In summing up the development of China's marine geophysical exploration, the importance of peace and unity is greatly felt. Without peace and unity, it would not be possible to concentrate all our efforts on the practical problems of production, nor would it be possible to promote the progress of marine geophysical exploration and produce qualified personnel and results.

The author believes that the chief characteristics of China's marine geophysical exploration lies in the comprehensive regional surveys of certain sea areas. Although it is a fact that gravitational field and magnetic field data and charts alone are very important, to obtain a relatively complete understanding of regional geology, we still have to combine them with seismic and depth-probing data. A productive, quicker, better and economical way of regional surveying is done by conducting several different types of probing simultaneously on the same exploration vessel, i.e. reflection seismic, gravitational, magnetic and depth probing. It is characterized by economy, high efficiency and precision. In marine surveys, it is difficult to put two separate measurements into a single line no matter how precise the navigational orientation may be. The only way to eliminate this problem and facilitate comprehensive interpretation is by conducting comprehensive surveys on the same exploration vessel. And the only way to eliminate multiple solutions which occur in the application of one type of method is by conducting comprehensive interpretation. Of course, what is even more important is to have an appropriate degree of theoretical guidance. Actually, the only way to make correct evaluation of oil and gas is by obtaining a relatively deep understanding of regional geology.

China's marine geophysical exploration has a very wide field of activity. The East China Sea is an arc-rear basin which had formed within an insular arc sea trench system as the Pacific plate shifted under the continental plate. The surveys and research on the border of the coalesced plate involve the transformation of the Pacific rock formation into the continental rock formation, as well as the generation of continental rock layers. The solution of such problems is not only of important theoretical significance, but also of practical significance for the prediction of subsea mineral resources, including petroleum and natural gas. As the South China Sea is a deep sea basin constituting a transitional crust between the mainland and the ocean, and there are rich oil and gas contents in its southern and northern edges, it goes without saying that it is of important value both from the theoretical aspect and the practical point of view. It would be unrealistic if we failed to exert our efforts in such stratigically important work and merely hope that marine geophysical exploration can provide drilling locations that can "immediately strike oil." This kind of unrealistic approach often makes it difficult to carry out work that cannot lead to direct discovery of minerals. One concrete example is the continuous lack of support for projects aimed at determining thermal currents at the bottom of the seas.

Lastly, the author believes that China's current marine geophysical exploration already possesses the prerequisite for rapid development. If we can properly handle the relations between basic theoretical research and practical production surveys, between regional geological surveys and oil drilling, and between the search for subsea petroleum and other mineral resources, China's marine geophysical exploration is bound to quickly contribute towards the four modernizations.

9119
CSO: 4008

DEVELOPMENT OF HIGHWAYS OF TAIWAN OUTLINED

Beijing DILI ZHISHI [GEOGRAPHICAL KNOWLEDGE] in Chinese No 5, May 79
pp 5-6, 9

[Article by Bi Fuchen [3968 4395 5256]: "Taiwan's Highways"]

[Editor's note: All figures are as given in original text]

[Text] Taiwan's highways were developed early. Highway transportation is very developed. Various kinds of highways extend throughout the island like spider webs. Every relatively large village and town can be reached by automobile. Highway transportation and travel by car are both very convenient. This article will mainly introduce the reader to the history of the development of Taiwan's highways, several major highways and the present situation of Taiwan's highway traffic.

1. The Development and Distribution of Highways

The development of Taiwan's highways began as early as the latter period of the Manchu Dynasty. In the 13th year of Tongzhi (1874), Imperial Envoy Shen Baozhen [3088 5508 4396] went to Taiwan to take charge of military affairs and engaged in the construction of official roads. At the time, a southern, northern and a central road were built. The northern road started in Ilan and passed through Taitung to reach Chilai. Total length was 100 kilometers. The central road started from Yunlin and reached Taitung. Total length was 132.5 kilometers. The southern road was divided into two lines. One began from Fengshan in Kaohsiung, passed through Ch'ishanchuang and reached Taitung. Its length was 120 kilometers. The other began from Fengshan in Kaohsiung, passed through Shech'a and reached Taitung. Its length was 132.5 kilometers. These roads became the foundation of later highway construction.

In 1895, Japan's invading armies occupied Taiwan. To facilitate military communication, the Japanese began to build a down-island highway running from north to south. By the second year, 428 kilometers were built. In later years, progress was made each year. Up to the time of Japan's surrender, a total of over 17,000 kilometers of highways had been completed. These roads did not have a uniform surface width. Only a small part was covered by asphalt or concrete surfaces. Most of the roads were macadam surfaced.

After 1949, and for the past 30 years, Taiwan's highway construction progressed further. First, the original highways were rebuilt year after year, including widening of the foundations, improving the road surfaces, rebuilding bridges and building of culverts. After 1956, three cross-island highways that connect Taiwan's east and west and one north-south expressway were built one after the other. At present, Taiwan has a total of 17,545.6 kilometers managed at the provincial, county and rural township levels. Provincial highways total 3,110.2 kilometers. County roads total 3,012.3 kilometers. Rural township roads total 11,094.9 kilometers. There are also 328.2 kilometers of special roads for factories and lumber yards. The provincial roads are the trunk lines and the county and rural township roads are the branch lines. Most road surfaces are asphalt or concrete and most roads are two lane roads. Throughout the entire island, on the average every two square kilometers contains one kilometer of highway. Taiwan is thus one of our nation's provinces with a rather high highway density. But seen from the distribution of highways, about 90 percent of roads are concentrated in the western plains. Roads in the central part and the eastern mountain regions are limited.

2. Major Highway Trunklines

At present, Taiwan's major highway trunk lines are: Round-the-island highway, the east-west cross-island highway, the northern cross-island highway, the southern cross-island highway and the north-south expressway. They are introduced one by one below:

Round-the-island highway: This highway starts from Keelung at the northern tip of Taiwan Island, passes through the city of Taipei and travels along the western sea coast of Taiwan towards the south until it reaches the southern most tip of Oluanpi, and then follows along Taiwan's eastern sea coast northward until it reaches Taipei. It circles the island once and travels a total of 1,031 kilometers. It can be divided into three sections: From the city of Keelung travelling south it passes through Taipei, Taoyuan, Hsinchu, Miaoli, Taichung, Chiayi, Tainan and Kaohsiung. This section is also called the north-south highway. It parallels the north-south down-island railroad. Before the north-south expressway was opened to traffic this was Taiwan's major highway. Its total length is 461.38 kilometers. Road surface has a width of 14.5 meters on flat land and 11 meters in mountain regions. The entire line has over 10 large bridges. One of these is the dual purpose bridge of Hsilo Highway and Railroad that crosses the Choshui Chi and is situated north of Hsilo and crosses the border between Yunlin and Changhua counties. It is the strategic point of the north-south highway. The bridge has 31 openings between trusses and the entire length is 1940 meters. The round-the-island highway branches off to the northeast from Taipei, passes through Ilan, Suao, Hualien and reaches Taitung. This is called the northern highway. The road between Suao and Hualien was chiseled into the cliffs along the sea coast. Underneath it lies the mist-covered and vast Pacific. The road winds through midsections of mountains, goes through tunnels and travels along like a long dragon.

In particular, the great cliff south of Ch'ingshui Station in Ilan County stands 700 meters above the sea and is the most dangerous place on the entire route. On one side the cliff stands erect and extends from the sea into the sky, on the other side is the vast expanse of the sea. The greatness of nature and the wonders of natural creation here known as the "Chingshui cliff" is one of eight famous natural wonders of Taiwan. The round-the-island highway extends southward from Kaohsiung, passes through Pingtung, Fengkang, and reaches the southern most tip of Taiwan called Oluanpi. The road turns eastward and goes north from Fengkang, passes through Tawu and reaches Taitung. This is called the southern highway. This round-the-island highway is the artery of Taiwan's highway transportation. Almost all other highways connect to it. This highway had been completed during the period of Japanese occupation and had already been opened to traffic.

The east-west cross-island highway: Work began in 1956 and was completed in May of 1960, and the highway was opened to traffic. The entire length is 348 kilometers. It is divided into a trunk line, a branch line and a limited access line. The main line is divided into two sections. One section begins from Tungshih urban township on the north-south highway in Taichung County and enters the mountains and travels upstream along the Tachia Chi, passes through Kukuan, Tachien, Lishan and along the Central Mountain Range via Sungling to Tayuling as the western section. The length is 116 kilometers. Another section begins from Liwu Chi and goes down to Kuanyuan, Tienhsiang to Taroko Gorge and connects with the Suao-Hualien highway as the eastern section of 78 kilometers long. A branch road starts from Lishan and turns towards the northeast and follows Tachia Chi upstream through Huanshan and Ssuyuan Pass (at 1948 meters above sea level), along Lanyang Chi downward to Ilan, totaling 112 kilometers. The limited access road was built during the construction phases to solve the problems of transportation of food and material supplies. It begins from Wushe in Nantou County and ends at Hohuan Pass on the trunk line. It is 42 kilometers long and its highest point is 3,275 meters above sea level. This highway crosses the central part of Taiwan and connects the east and west. Along the road are thousands of different rocks and tens of thousands of mountains and valleys. The road winds through primeval forests and high mountains and the scenery changes kaleidoscopically and is very beautiful.

The northern cross-island highway: Construction began in May, 1963, and the road was completed in May 1966, and opened to traffic. The highway begins at Tap'u Village in Taipei County, passes Taoyuan County, through the Central Mountain Range and turns into the east-west cross island highway's Ilan branch line, covering a total of 120 kilometers. Along the road there are mountains and water falls and cars frequently wind through cliffs and deep valleys, thousands of circles and hundreds of turns, and the road is treacherous.

The southern cross-island highway: Construction began in July, 1968, and the entire road was opened to traffic in October, 1972. It begins at Yuching in Tainan County in the west, passes through Nanpei Rural Township extends to Kaohsiung County, through Chiahsien, Taoyuan and into Taitung County, then through Litao, Haituan and connects with the Hualien-Taitung Highway, covering a total of 182 kilometers. This is the third cross-island highway that threads through the Central Mountain Range and connects east and west. The road is surrounded by Laonung Chi and Hsinwulu Chi. Along these waterways are high mountains and magnificent peaks, ancient trees that shoot up into the sky and there are many hot springs.

The construction of these three cross-island highways is significant in changing the distribution of Taiwan's highways and the development of the central part and resources of the eastern mountain regions. In particular, they have directly benefited the development of Taiwan's forest resources and marble resources of the east. Travelling between east and west need not depend upon the round-the-island highway anymore. Time has been greatly shortened. At the same time, the highways have stimulated the production of fruits of the mountain temperate zone such as pears, peaches, loquats and apples. Lishan situated in the mountains of the Central Range has become a major location for the production of Taiwan's temperate fruits.

The north-south expressway: Construction began in September, 1971 and the expressway was opened to traffic in October, 1978. This is a new artery of north and south traffic on Taiwan. It begins in the north at Keelung and reaches Kaohsiung in the south. The expressway is almost parallel to the original north-south highway and it has branch roads connecting Taoyuan and Kaohsiung airports and Taichung port. It is 373.5 kilometers in its entirety. The expressway has a stretch of 16.5 kilometers with eight lanes (eight cars travel parallel and the road surface is 43 meters wide), 18.4 kilometers with six lanes (35 meters wide) and 338.5 kilometers with four lanes (28 meters wide). In the center of the expressway is a divide that separates the cars travelling in opposite directions. The entire expressway crosses over other roads and railroads on overpasses. In plains, travelling speed can reach 120 kilometers per hour. In hilly regions, travelling speed can reach 90 kilometers per hour. Cars enter and exit from on and off ramps which connect to other roads. The entire expressway has 37 enter and exit ramps, averaging one every 10 kilometers.

After this expressway was opened to traffic, it was able to change the bottleneck situation on the highways of western Taiwan and reduce the pressure upon the north-south highway. The expressway is shorter than the north-south highway by 37 kilometers. The distance between Taipei and Kaohsiung is 359 kilometers. On such a wide and flat road surface, the time of travel by car has been reduced from 8 hours to 4 hours. Large passenger buses take 4 hours and 30 minutes. Four years ago when the Taipei Yangmei section of the expressway opened to traffic, the daily traffic was over 7,000 cars per day. After the entire expressway was opened to traffic, the traffic increased to over 32,000 cars. The obvious economic benefits of this expressway are reduced travel time, reduced cost of transport and increased traffic flow, and it will definitely stimulate economic development of towns and villages along the expressway.

3. A View of Highway Transportation

The amount of water in rivers of Taiwan is usually small. During the rainy season, the water flows rapidly and therefore the rivers are not suitable for travel by boat. Traffic on the island has always been mainly by land. In recent years, as industry, commerce, export processing industry and tourism developed, highway traffic and transportation have become an important link in Taiwan's economic development. Especially after the expressway was opened to traffic, it has exerted a definite effect upon passenger and cargo transport by Taiwan's north-south railroad. In the future, Taiwan's highway transport and railroad transport will enter into fierce competition, while inland transport and transportation in mountain regions will still depend mainly on highways. Up to the end of 1978, Taiwan had 45 ordinary passenger transport companies, with a fleet of 4,858 buses. Special passenger transport companies totalled 311 with 1,675 cars. Ordinary cargo transport companies numbered 1,892 with 2,831 trucks. Special trucking firms numbered 162 with 1,616 trucks. Highway traffic also increased greatly. As of the end of June, 1977, Taiwan had a total of over 2,370,000 various types of motorized vehicles. In 1977, the total passenger load carried by the Taiwan provincial highway bureau reached over 340 million passengers, privately operated passenger transport companies about 700 million passengers a year, and the total amount of cargo transported amounted to over 100 million tons. Cargo transport can be divided into loose cargo and containerized cargo (i.e., cargo shipped in containers of uniform size). Loose cargo transport involves mainly shipment of vegetables, fruits, hogs, fowl, aquatic products and other agricultural sidelines. Container cargo is something that developed at the beginning of the 1970s. It involves shipments of commercial products, export and import materials such as textiles, plastic products and electrical appliances.

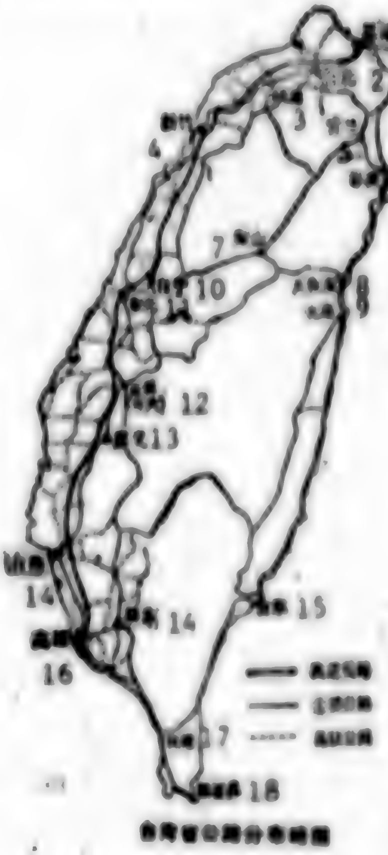
Taiwan's highway traffic has many shortcomings because of the social system and management problems. For example, the construction of the three cross island highways that connect Taiwan's east and west and the north-south expressway are all tremendous engineering projects. Main construction workers were those kicked out of the military, large groups of mainlanders who were old and retired soldiers with no homes and no way to make a living and unemployed people from the towns and villages. Most of them were over 50 years old. Many died at the construction sites because of physical weakness or engineering mishaps. Yet, these highways do not belong to the people. Taking the three cross island highways as an example, because the Taiwan authorities have implemented "a curfew over the mountain regions," all cars and people entering the Central Mountain Range via these three highways must register with the police and are allowed to use the roads only after they receive approval. Therefore, the effectiveness of these three highways is greatly affected. Again for example, large and small cars on Taiwan must pay liscense fees and when they cross a bridge (one round trip) they have to pay toll to replenish the cost of building the bridge. This has been criticized by various sectors of the society. Some bridges have ceased to levy tolls but there are still 35 bridges which continue to levy a toll. The large and small cars that travel the expressway must pay a fee frequently causing a long waiting line at the toll booth. In addition, as the number of cars and the amount of traffic increases rapidly, traffic accidents have increased year after year. In 1975, car accidents totaled 9,736. In 1976, this figure increased to 10,906. After the expressway was opened to traffic, cars travel fast, and because of overly close tailing distances and the poor quality of tires causing blowouts, car accidents are frequent and the accidents are usually more disastrous than on ordinary highways. For example, on the morning of 5 January 1979, at 14 to 16 kilometers from Keelung, three automobile accidents occurred in succession, causing destruction of 27 automobiles and many injured and dead.

Distribution of Highways on Taiwan Province

Key:

1. Keelung
2. Taipei
3. Taoyuan
4. Hsinchu
5. Ilan
6. Suao
7. Lishan
8. Taroko Gorge
9. Hualien
10. Taichung
11. Changhua
12. Yunlin (Touliu)
13. Chiayi
14. Tainan Pingtung
15. Taitung
16. Kaohsiung
17. Fengkang
18. Oluanpi

═══ Expressway
——— Major highway
------ County highway



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PHYSICAL SCIENCES

BIOLOGICAL MARKER HYDROCARBONS IN SOURCE ROCK, CRUDE OIL OF SOME BASINS

Beijing SHIYOU XUEBAO [ACTA PETROLEI SINICA] in Chinese Vol 1 No 1, Jan 80 pp 52-61

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[Text] **Foreword**

Triterpanes and steroidal alkanes extracted from crude oil and its sedimentary rocks are well known by all to be biological marker compounds. They originate from the organic mother material in sedimentary basins. The characteristic of these compounds is that they are very stable in the rock formation process, therefore, they can be used to differentiate different crude oils and source rocks. The purpose of studying these chemical compounds is to examine the correlation between crude oil and source rocks and between different crudes. This can provide important information regarding migratory shifts, aggregation and maturity of crude oils and the information can be applied in petroleum exploration.(1-6) In recent years, application of these kinds of techniques have developed rapidly. Some scholars(2,4,5,7,8) have developed many methods in this field and have achieved some interesting results.

Progress in modern instrument analysis such as liquid chromatography, capillary gas chromatography, analysis of magnetic resonance of ^{13}C nuclei and joint chromatography-mass spectrometry techniques have provided the possibility of rapid selection and routine analysis on the molecular level. McLafferty(11, 12) et al has given a lot of attention to the application of the MIKE technique of mass spectrometry of the ion kinetic spectrum. Burlingam, Hills, Enaminger also reported on the separation and determination of triterpanes and steroidal alkanes in crude oil, oil shale, coal and sedimentary rocks. Dorsselaer A. Van and Kimble also did a lot of work in the separation and determination of the hopane series.(11)

This article studies the biological marker compounds discovered in some basins in China and explores their applicability in studying the migration of crude oil, the correlation between source rock and crude and between crude oil and the maturity of crude oils. In addition, a "degraded" hopane compound was discovered in heavy napthenic crude. The results are discussed here.

Experimental Part

Origin of the sample: Five rock samples and seven oil samples were taken from different layers of oil deposits. The samples taken from the Songjiang-Liaoning Basin belong to the lower Cretaceous. This period consists mainly of two layers of source crude. The group at Qingshankou took a pair of rock and oil samples. The Nunjiang group took a pair of rock and oil samples, but the oil samples were mixed oil samples. Samples taken from the Shaanxi, Gansu-Ningxia Basin belong to the lower Jurassic and the upper Triassic. The former is a geological layer of coal beds. The three pairs of rock samples and oil samples were separately taken from the lower Juriassic and the upper Triassic. The crude oil from the Shanxi well 7 in the north China region belongs to the lower Tertiary (Table 1).

Pretreatment of Samples: After the rock samples were pulverized, they were extracted by a Soxhlet apparatus using chloroform. The extract was distilled to remove the solution and then washed and chromatographically separated. The crude oil was distilled under reduced pressure (vacuum of 0.2 millimeter of mercury) and a fraction of 400-520°C (760 millimeters of mercury) was taken, washed and chromatographically separated.

Liquid Chromatography: Pretreated samples are first chromatographically washed to obtain saturated hydrocarbons using silica gel as the adsorbent and hexane as the washing agent. Saturated hydrocarbons without solution were then further separated by high precision liquid chromatography (HPLC) to obtain condensates of triterpanes and steroidal alkanes. The instrument used to perform high precision liquid chromatography was the JASCO FLC-350 using purified n-hexane as solution flowing at 0.35 millililiter/minute under a pressure of 20 kilograms/centimeter^2. The filler was 5 to 7 micrometers of silica gel (produced in Qingdao). The column was 150 millimeters x 2.3 millimeters (inner diameter). The identifier was the differential refractometer model RI x 8. The amount of the samples fed was 2 to 3 millililiters. Collection was done 10 times to gather a sufficiently large amount of condensates. Quantitative data of saturated hydrocarbons were also obtained by HPLC but the sample fed was only 50 micrograms. Other conditions were the same as the above.

Combined Chromatography-mass Spectrometry: The VARIAN AEROGRAPH 2740 chromatograph--MAT 311 mass spectrometer--SS100MS data system was used. The bilevel Waston-Biemann separator was used as the molecular separator. The chromatographic column was a SCOT glass capillary column (OV-17,

Table 1. Basic Data of Analyzed Samples

1) [illegible]	2) [illegible]	10) [illegible]	13) [illegible]	26) [illegible] (m)	27) [illegible]	33) [illegible]	36) [illegible]
1	3) [illegible]	11) [illegible]	14) [illegible] 15	1602—1657	28) [illegible]	34) [illegible] 6	37) [illegible]
1 [illegible]		12) [illegible]	15) [illegible] 36	1681—1701	[illegible]	[illegible] 7	[illegible]
2	4) [illegible]	[illegible]	16) [illegible] 50	1318—1364	29) [illegible]	35) [illegible] 10	[illegible]
2 [illegible]		[illegible]	17) [illegible] 9	1375—1380	[illegible]	[illegible] 9	[illegible]
3	5) [illegible]	[illegible]	18) [illegible] 55	1263—1278	[illegible]	[illegible] 4+5	[illegible]
3 [illegible]		[illegible]	19) [illegible] 9	1318—1360	[illegible]	[illegible] 6+8	[illegible]
4	6) [illegible]	[illegible]	20) [illegible] 10		30) [illegible]	P	[illegible]
4 [illegible]		[illegible]	21) [illegible] 6	1507.0	[illegible]	qn_1	[illegible]
5	7) [illegible]	[illegible]	22) [illegible] 7①		[illegible]	H	[illegible]
5 [illegible]		[illegible]	23) [illegible] 203	690.4	[illegible]	n_1	[illegible]
6	8) [illegible]	[illegible]	24) [illegible] 1	5700	31) [illegible]	N	38) [illegible]
7	9) [illegible]	[illegible]	25) [illegible] 7	1933—1423	32) [illegible]	E_s	[illegible]

39) ① [illegible].

Key:

1)	Numerical codes of samples	21)	Xing 6
2)	Basins	22)	Gu 7(1)
3)	Shaanxi	23)	Sa qi 203
4)	Gansu	24)	Ke san 1
5)	Ningxia	25)	Jin 7
6)	Songjiang	26)	Depth of well (meters)
7)	Liaoning	27)	Geological age
8)	Tarim	28)	Upper Triassic
9)	North China	29)	Lower Jurassic
10)	Types	30)	Lower Cretaceous
11)	Crude oil	31)	Upper Tertiary
12)	Source rock	32)	Lower Tertiary
13)	Well number	33)	Number of geological layer
14)	Yang 15	34)	Long 6
15)	Qing 36	35)	Long 7
16)	Ling 50	36)	Sedimentary Phase
17)	Ling 9	37)	Continental deposit
18)	Ling 55	38)	Marine deposit
19)	Ling 9	39)	(1) is mixed oil sample
20)	Sa zhong 10		

30 meters x 0.4 millimeter inner diameter), temperature of the column was 275°C, sample feeding temperature was 350°C, temperature of the molecular separator was 300°C, speed of flow of helium gas was 2 millimeters/minute, the ionized voltage was 70 electron volts, the firing current was 300μA, and the scanning speed was 3 seconds/10 x mass number.

MIKE Spectrometry: The MAT 311 mass spectrometer was used.

The analytical flow chart is illustrated in Figure 1.

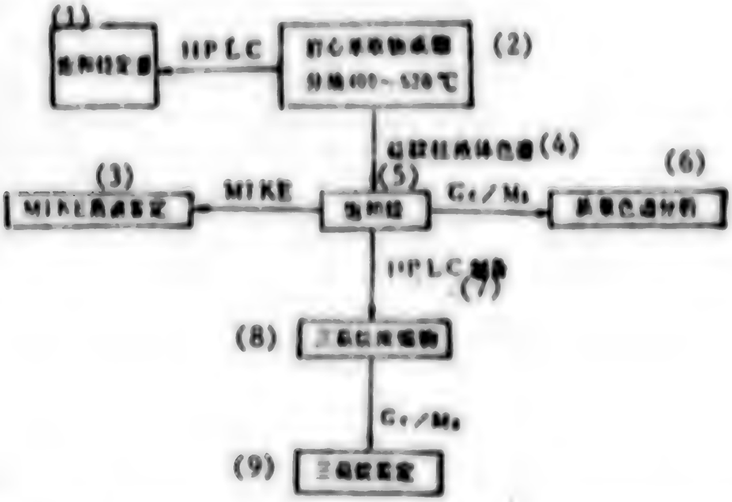

Figure 1. Flow chart of the entire analysis process

Key:
1) Quantization of saturated hydrocarbons
2) Extracts from rock core or distillate oil at 400-520°C
3) MIKE mass spectrometric identification
4) Silica gel columnar liquid chromatograph
5) Saturated hydrocarbons
6) Mass spectrometric analysis
7) HPLC preparation
8) Triterpane condensates
9) Triterpane identification

Discussion of Results

1. Fingerprints of Crude Oil

The mass spectrograms of steroidal alkanes and terpanes have distinct characteristics. Their molecular peaks are strong. The critical cracking peak of terpanes is m/e 191, that of steroidal alkanes is m/e 217. The chromatograms of the mass of these compounds can provide important information about the fingerprints of mineral fuels. The chromatogram of the mass of m/e 191 shows the distribution of the triterpane series, and as the typical chromatogram of the mass of the samples shows in Figure 4, the chemical groups to which the major peaks belong are identified by the chromatograms of mass of m/e 177, 199, 205, 370, 384, 398, 412, 426, 440, 454 and 468 (Table 2, Figure 2).

Table 2. Identification of the Structures of the Various Peaks of the Mass Spectrograms of Triterpanes

1) 峰号	2) 分子式	3) 结构鉴定	13) 鉴定依据①
1	[illegible]	18α(H)22,29,30 三降藿烷 4)	14) [illegible]
2	[illegible]	17α(H)22,29,30 三降藿烷	[illegible]
3	[illegible]	五环三萜烷 5)	[illegible]
4	[illegible]	17α(H), 21β(H)-30 降藿烷 6)	[illegible]
5	[illegible]	17β(H), 21α(H)-30 降藿烷	[illegible]
6	[illegible]	17α(H), 21β(H)藿烷，肩峰为Oleanane 7)	[illegible]
7	[illegible]	17β(H), 21α(H)藿烷 8)	[illegible]
8	[illegible]	22S 和22R 17α(H), 21β(H) 30-升藿烷 9)	[illegible]
9	[illegible]	同 12 上	[illegible]
10	[illegible]	22S 和22R 17α(H), 21β(H) 30,31 二升藿烷 10)	[illegible]
11	[illegible]	同 14 上	[illegible]
12	[illegible]	22S 和22R 17α(H), 21β(H) 30,31,32 三升藿烷 11)	[illegible]
13	[illegible]	同 上 12)	[illegible]
14	[illegible]	22S 和22R 17α(H),21β(H) 30,31,32,33 四升藿烷	[illegible]
15	[illegible]	同 上	[illegible]

①见Seifert, Whitehead.

Key:

1)	Code number of peaks	8)	Hopane
2)	Molecular formula	9)	Homohopane
3)	Structure identification	10)	Di-homohopane
4)	Tri-norhopane	11)	Tri-homohopane
5)	Pentacyclotriterpane	12)	Tetra-homohopane
6)	Norhopane	13)	Basis of identification①
7)	Hopane: the shoulder is Oleanane	14)	Chromatogram of mass

① See Seifert, Whitehead.

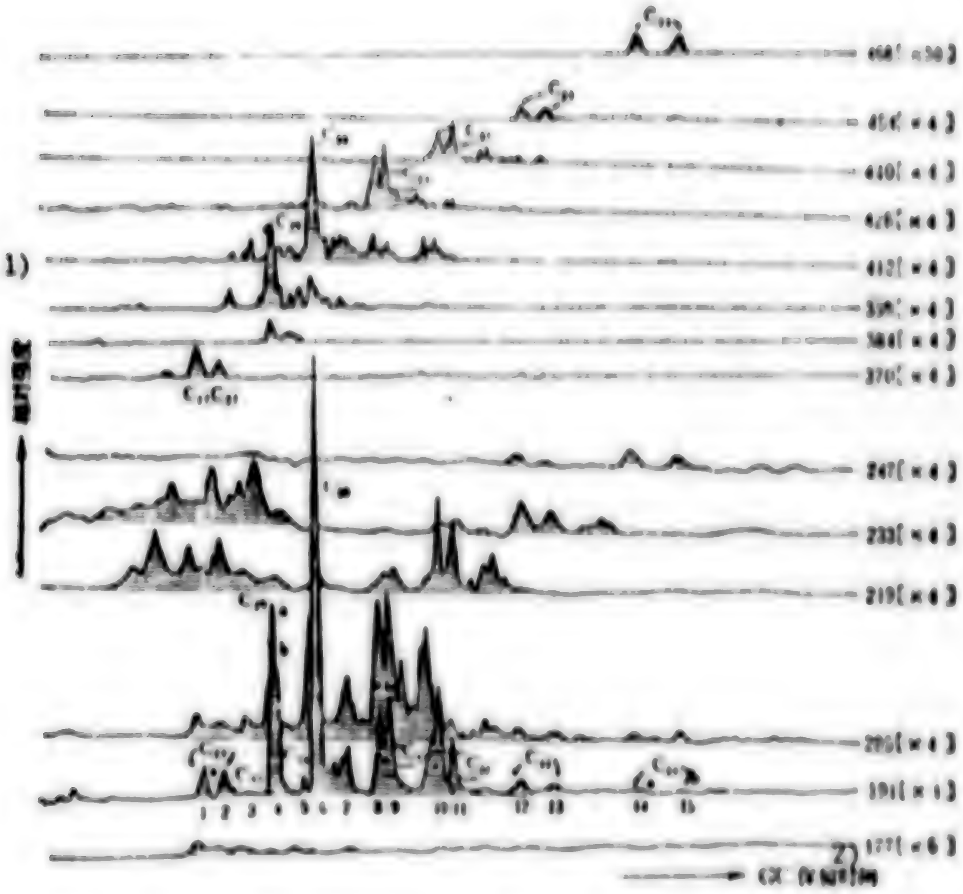

Figure 2. Chromatograms of the mass of 4-S samples

Key: 1) Relative intensity 2) GC retension time

The characteristics of crude oils from different sedimentary basins can be reflected by the m/e 191 diagrams of chromatographic fingerprints of mass (Figure 3). The horizontal axis represents the numerical codes of terpane compounds. The vertical axis represents the relative intensities of the peaks. Of course, the shape of each curve will not be entirely the same, but the crude oils from the same basin have a definite degree of similarity while crude oils from different basins show a lot of differences. The distribution of the peaks of the m/e 205 chromatogram of mass can also be used as supplementary proof. The retention times of the m/e 191 chromatogram and the m/e 205 chromatogram of mass are consistent.

It must be pointed out that in determining the fingerprints of different crudes, the distribution of their compounds must be compared and the stereoisomers of trirerpane compounds must also be studied. This information may be related to the maturity, migration, aggregation and the environment of

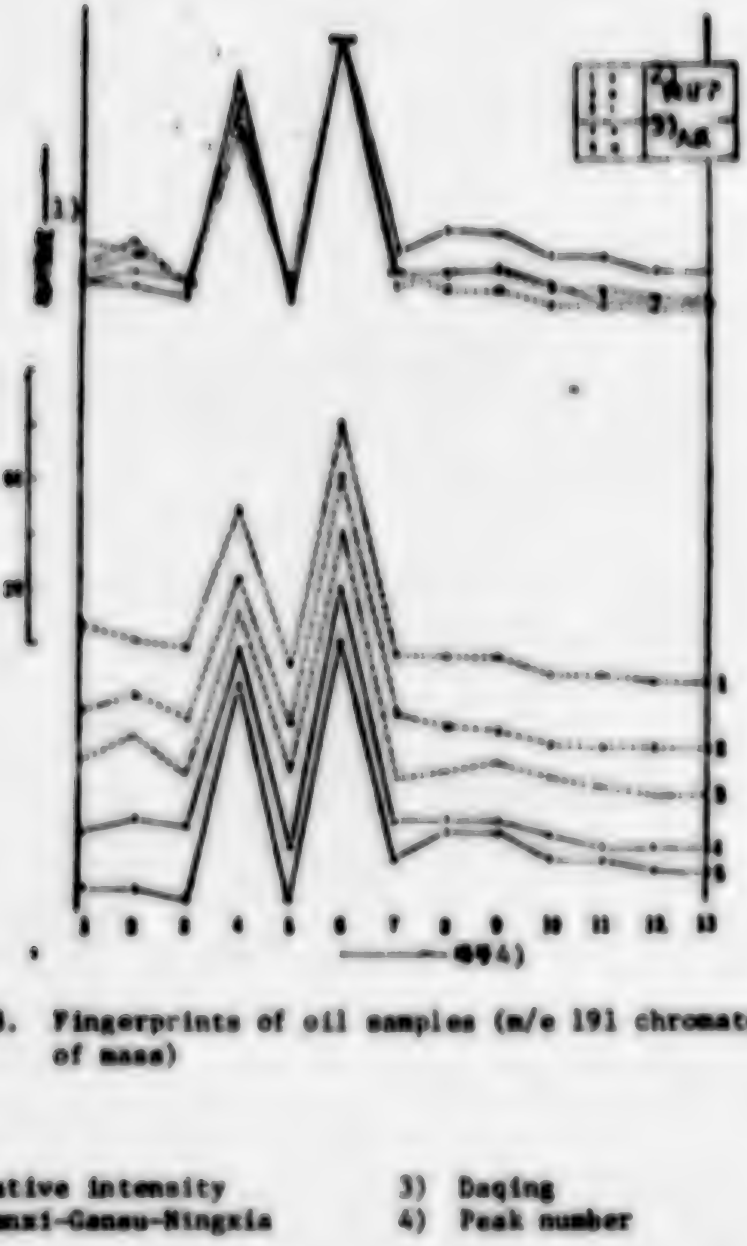

Figure 3. Fingerprints of oil samples (m/e 191 chromatogram of mass)

Key:

1) Relative intensity
2) Shaanxi-Gansu-Ningxia
3) Daqing
4) Peak number

genesis of the crudes. For example, it is generally believed that most of the crudes from continental facies contain more oleanane (Oleanane), which can be identified by the shoulder of peak No 6 (See Figure 4a). Oleanane may possibly be present in the chromatogram of mass of the crude from the Shaanxi-Gansu-Ningxia Basin. It may be an indication of sedimentation of a continental facie. But it has not been discovered in the crude from Daqing. This may be related to the mother material of the source of crude oil genesis. The 3-5 of the extracts of the rock core from the lower Jurassic of

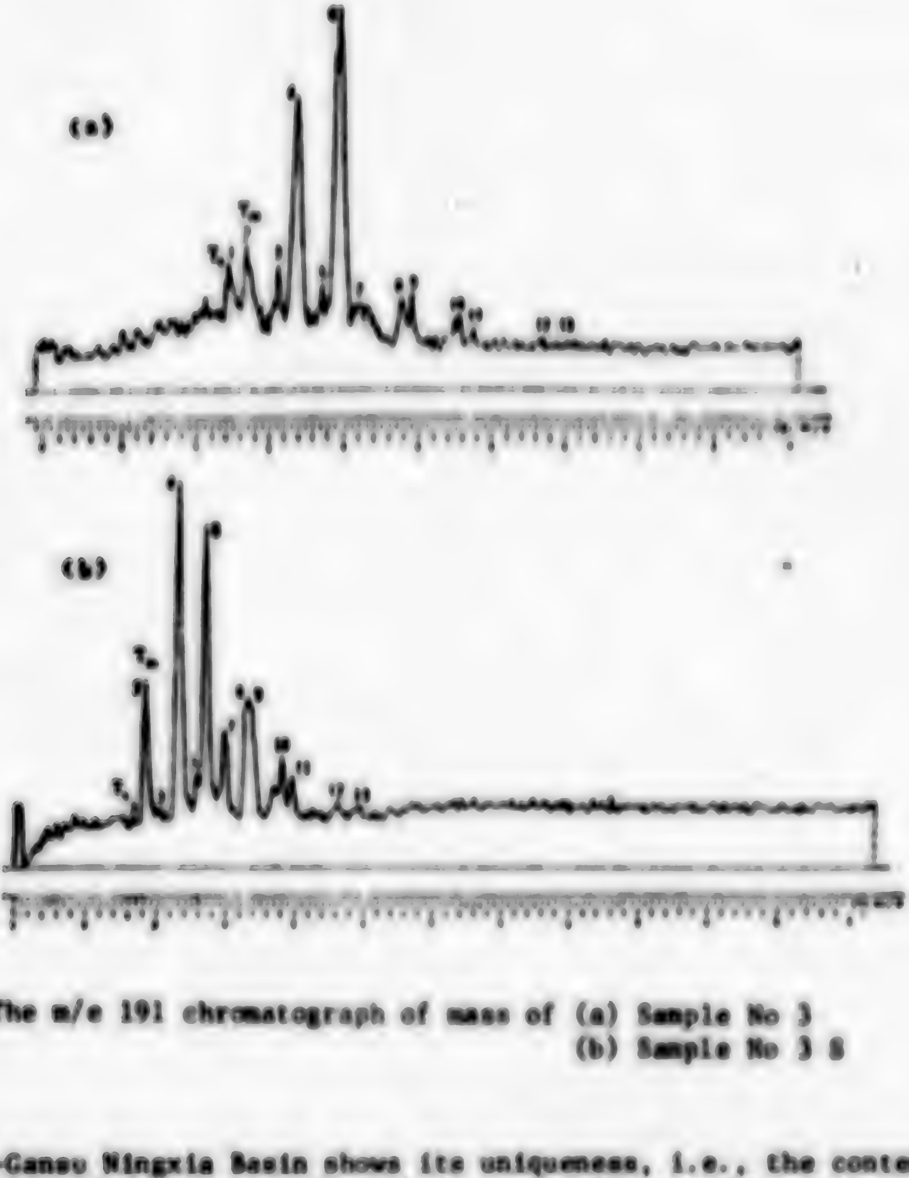

Figure 4. The m/e 191 chromatograph of mass of (a) Sample No 3
(b) Sample No 3 S

the Shaanxi-Gansu Ningxia Basin shows its uniqueness, i.e., the content of 18α(H)-22, 29, 30-3-norhopane II (Ts) is minute (Figure 5b), while another extract (1-S) of rock core from the basin contained relatively more 18α(H)-22,29,30-3-norhopane II. This can explain the difference in the fingerprints of different strata in the same basin.

2. The Correlation Between Source Rock/Crude and Crude/Crude

Some writers have published various methods and have established parameters on the basis of analysis of biological marker compounds, and studied them in combination with other "macro" parameters including data of the relative contents of ^{13}C and chain hydrocarbons of isopentadienes. We used each related chromatographic peak of the m/e 191 chromatogram of mass to repre-

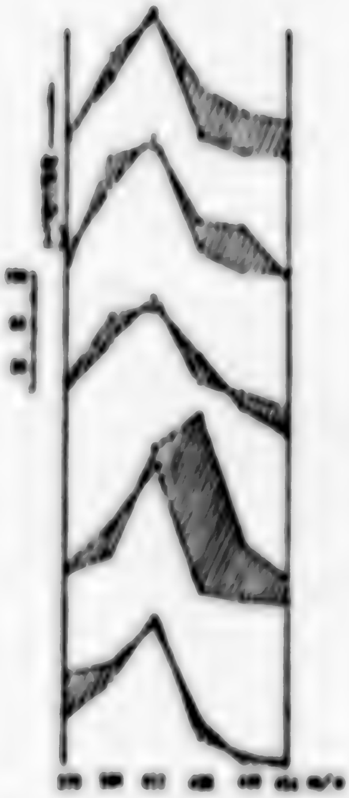

Figure 5. Diagram of correlation between source rock and crude of steroidal alkanes

x Crude . Source rock

Key: 1) Relative intensity

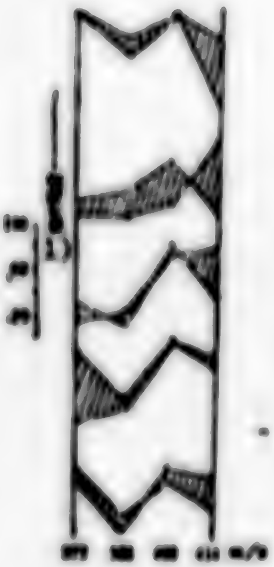

Figure 6. Diagram of correlation between source rock and crude of triterpane

x Crude . Source rock

Key: 1) Relative intensity

sent the C_{27}-C_{34} of triterpanes, and measured the relative intensities of the peaks to represent the relative contents. We used m/e 217 for steroidal alkanes and used the same method described above to measure the relative contents of the C_{27}-C_{30} range. The correlation of composition of each pair of samples of crude and source rock could be examined by the distribution of the compounds of triterpanes and steroidal alkanes (Figure 5, Figure 6). Comparison of the three pairs of source rock and crude oil of the Shaanxi-Gansu Ningxia Basin shows that the Chang 7 and Chang 6 (samples Nos 1-8/1) of the upper Triassic are relatively well correlated, while the Yan 9 and Yan 10 of the lower Jurassic (sample Nos 2-8/2) are not consistent (Figure 6). Another pair of Yan 6 + 8 and Yan 4 + 5 of the lower Jurassic (sample Nos 3-8/3) are also different. Conversely, the three crude oil samples from the Shaanxi-Gansu-Ningxia Basin, i.e., Chang 6, Yan 10 and Yan 4 + 5 are very similar (Figure 3). These results hint that crude oil may have originated from the upper Triassic and then migrated to the oil depository layer of the lower Jurassic.

The two pairs of source rock and crude oil samples of the Songjiang-Liaoning Basin are relatively clearly correlated and the two samples of crude are also very similar. It is obvious that complete consistency in composition of the source rock and crude oil does not exist.

3. Maturity of Crude Oil

The maturity of crude oil can be expressed by a series of characteristics on the molecular level based on biological marker compounds, and examined in combination with some macro-parameters, such as the content of saturated hydrocarbons and odd-even superiority ratio (OEP) value.(8) This article has selected five parameters to express maturity of crude oil (see Table 3). From the point of view of organic geochemistry, it is unanimously believed that the most mature crude oil contains the most saturated hydrocarbons. Seifert recommends the use of the two stereoisomers of triterpane $C_{27}H_{46}$, i.e., 18α(H) 22, 29,30-3-norhopane and 17α(H)22,29,30-3-norhopane to separately represent the stable (T_s) and the easily maturing (T_m) compounds and the value of the ratio T_m/T_s as data on maturity. The greater the degree of maturity the smaller the value of T_m/T_s. Other parameters such as the content of saturated hydrocarbons, the values of the odd-even superiority ratio (OEP values) and the ratios of (2,6,10,14-tetramethylpentadecane/3,7,11,15-tetramethylhexadecane) can also be used to explain the degree of maturity as a supplementary means. The ratios of T_m/T_s in Table 3 show the degrees of maturity of the three samples of crudes taken from the Shaanxi-Gansu-Ningxia Basin are close. Of these, the crude taken from the upper Triassic (sample No 1) seemed to have a higher degree of maturity. The three rock core extracts taken from the basin showed obvious differences in the degrees of maturity. Of these, the degree of maturity of the sample taken from the upper Triassic was much higher than that taken from the lower Jurassic. It can be seen from a comparison of the crudes and their related rock core samples that the T_m/T_s values of the rock and crude samples of Sample No 1 (upper Triassic) are very close, while the values of samples No 2 and No 3 (lower Jurassic) are different. This again provides a proof of the view that crude oil migrated from the upper Triassic to the lower Jurassic. The degrees of maturity of the two samples of crudes taken from the Songjiang-Liaoning Basin were similar, but were lower than those of the crude taken from the Shaanxi-Gansu-Ningxia Basin. The crude taken from Kecan 1 Well in Xinjiang is a unique oil. Its content of saturated hydrocarbons is very high, reaching 91.2 percent, while its content of triterpane is minute. It can be said to be a highly mature oil.

4. "Degraded" Hopanes of the North China Basin

A series of "degraded" hopanes was discovered in the crude of the Jin 7 Well of the Tertiary below the north China Basin. The characteristic factor of that crude was 11.15 (K value) and it is a heavy naphthene-base oil. A fraction at 450-480°C was taken and separated by liquid chromatography to obtain saturated hydrocarbons. Using the MIKE technique of mass analysis by ion kinetic spectrum, a series of MIKE spectrograms of m/e 356,

Table 3. Table of Order of Maturities

1) [illegible]	5) [illegible]	8) [illegible]	9) [illegible]	[illegible]① 14) (%)	15) [illegible]		OEP	P_r/P_h
					$C_{27}+C_{28}/\sum C_i$ ②	T_m/T_s ③		
2) [illegible]	6) [illegible]	1	10) [illegible]	68.6	0.17	0.4	1.09	0.96
		2	11) [illegible]	61.7	0.10	0.8	1.08	0.88
		3	11) [illegible]	61.8	0.16	0.8	1.07	1.10
3) [illegible]		4	12) [illegible]	59.9	0.09	1.0	1.14	1.00
		5	12) [illegible]	91.0	0.08	1.0	1.04	1.35
4) [illegible]		6	13) [illegible]	81.3	—	—	—	—
2) [illegible]	7) [illegible]	1-B	10) [illegible]	60.5	0.36	0.5	1.08	1.21
		2 B	11) [illegible]	17.7	0.4	1.4	1.35	1.04
		3 B	11) [illegible]	65.0	0.18	18	1.15	1.04
3) [illegible]		4-B	12) [illegible]	60.0	0.08	6.0	1.30	—
		5 B	12) [illegible]		0.07	2.6	1.10	1.00

① HPLC identification of [words illegible] is made from the comparison of the heights of peaks in the m/e 191 chromatograms of mass

③ T 18 α(H)22,29,30-trinorhopane (peak position determined by the peaks in the m/e 370 mass chromatogram)

T 17 α(H)27,29,30-trinorhopane (Quantized by the height of peaks in the m/e 191 mass chromatogram)

Key:

1)	Basins	9)	Geological age
2)	Shaanxi-Gansu-Ningxia Basin	10)	Upper Triassic
3)	Songjiang-Liaoning Basin	11)	Lower Jurassic
4)	Tarim Basin	12)	Lower Cretaceous
5)	Type	13)	Upper Tertiary
6)	Crude oil	14)	Weight of saturated hydrocarbons (1)
7)	Source rock	15)	Triterpanes
8)	Number codes of samples		

384, 398, 412, 426 and 440 were obtained (Figure 7). For example, the strong m/e 177 peak in the MIKE m/e 384 spectrogram can be regarded as the fraction peak of pentacyclotriterpane. The m/e M-29 spectrogram shows that this triterpane (I) contains one ethyl group. The m/e 177, m/e 199 and m/e 355 peaks in the MIKE m/e 398 spectrogram show triterpane (II) contains one propyl group.

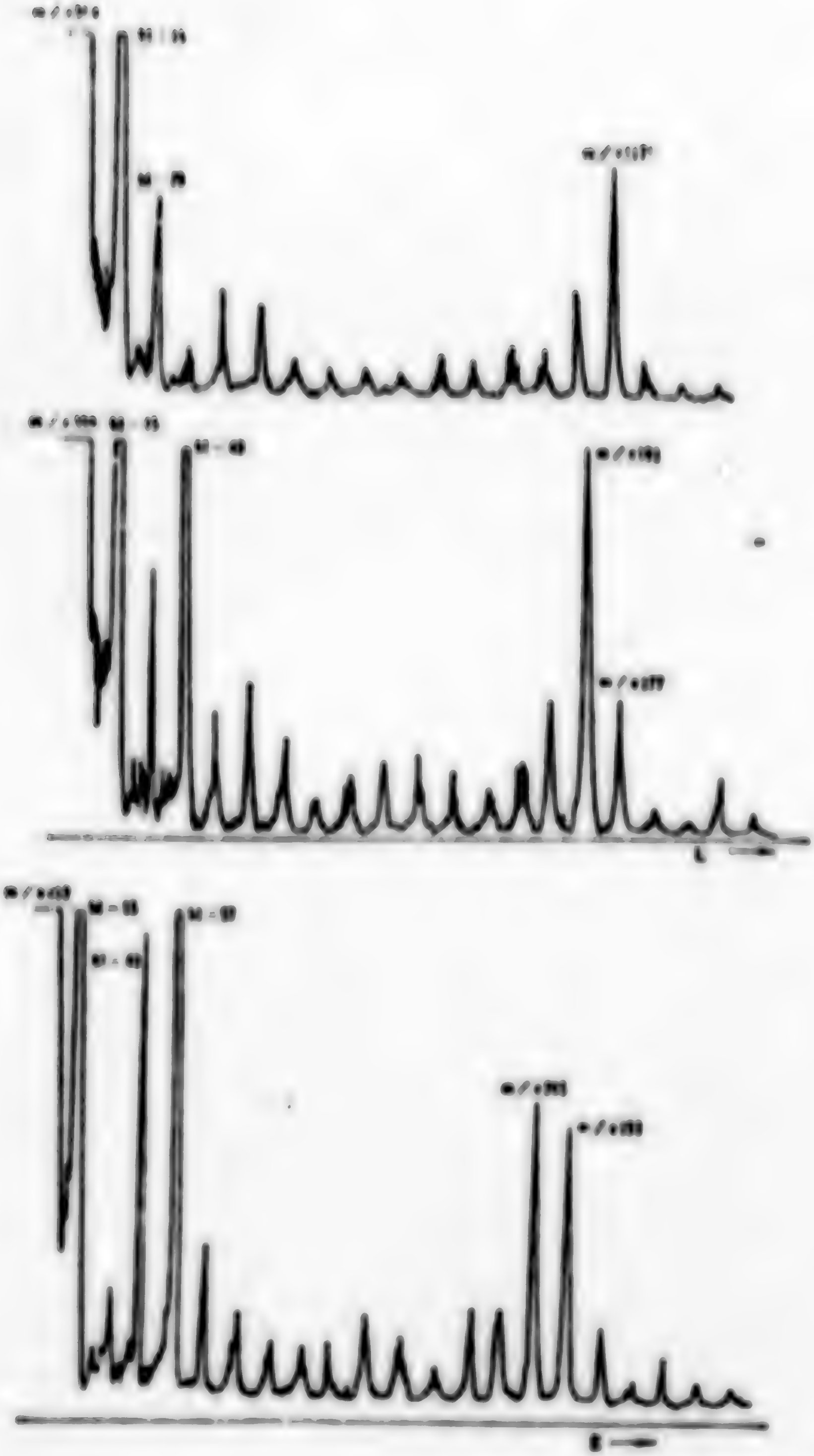

Figure 7. MIKE spectrograms of m/e 384, 398, and 412.

It can be clearly seen from a series of MIKE spectrograms that a "degraded" hopane type (III) exists and it differs from ordinary hopane by the fact that there is only one methyl group attached at C_{-4}.

To further prove the analytical results obtained by the MIKE technique, analysis was also conducted by chromatography and combined chromatography-mass spectrometry. It can be seen from a series of chromatograms of mass that there is a series of "degraded" hopanes including highest contents of $C_{28}H_{44}$ and $C_{29}H_{50}$ (Figures 8, 9).

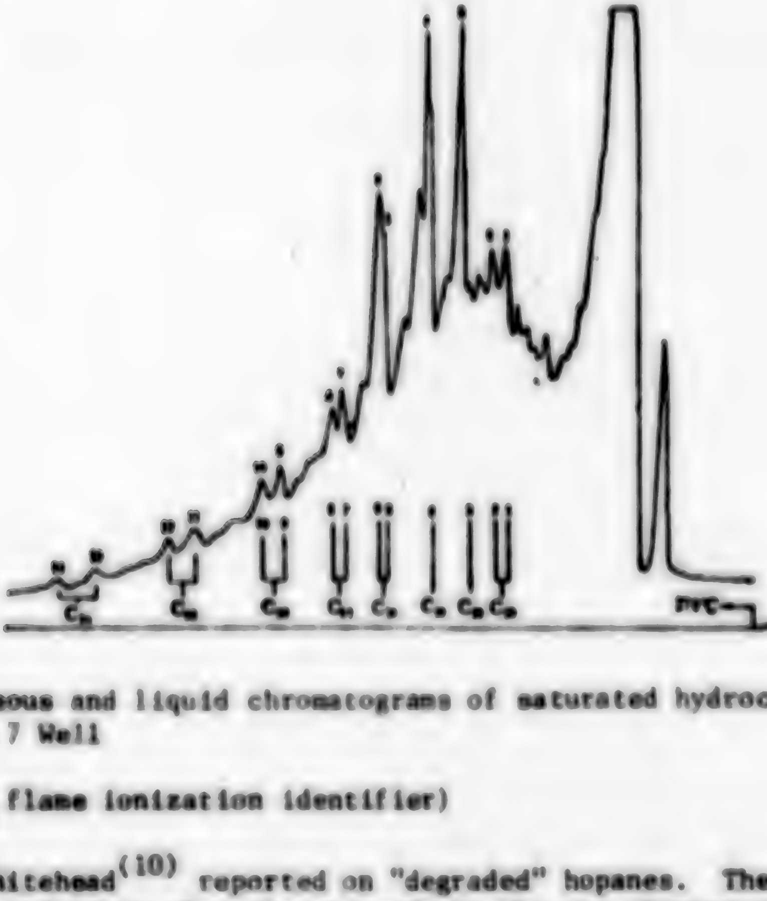

Figure 8. Gaseous and liquid chromatograms of saturated hydrocarbons from Jin 7 Well

(H_2 flame ionization identifier)

Read(13) and Whitehead(10) reported on "degraded" hopanes. The latter discovered the existence of such compounds in the gas chromatography of Nigerian crude. The study of Jin 7 Well in this article may be a supplement.

The m/e 191 peak in the MIKE spectrogram hints that besides "degraded hopanes," there may possibly exist ordinary hopane types as well, therefore the "degraded" hopane may have been produced as a result of degradation of ordinary hopane by microorganisms. The sample of the crude taken from that well came from a depth of 1332 to 1432 meters above the weathering surface and there is a large amount of water present. These may be the conditions for this kind of degradation.

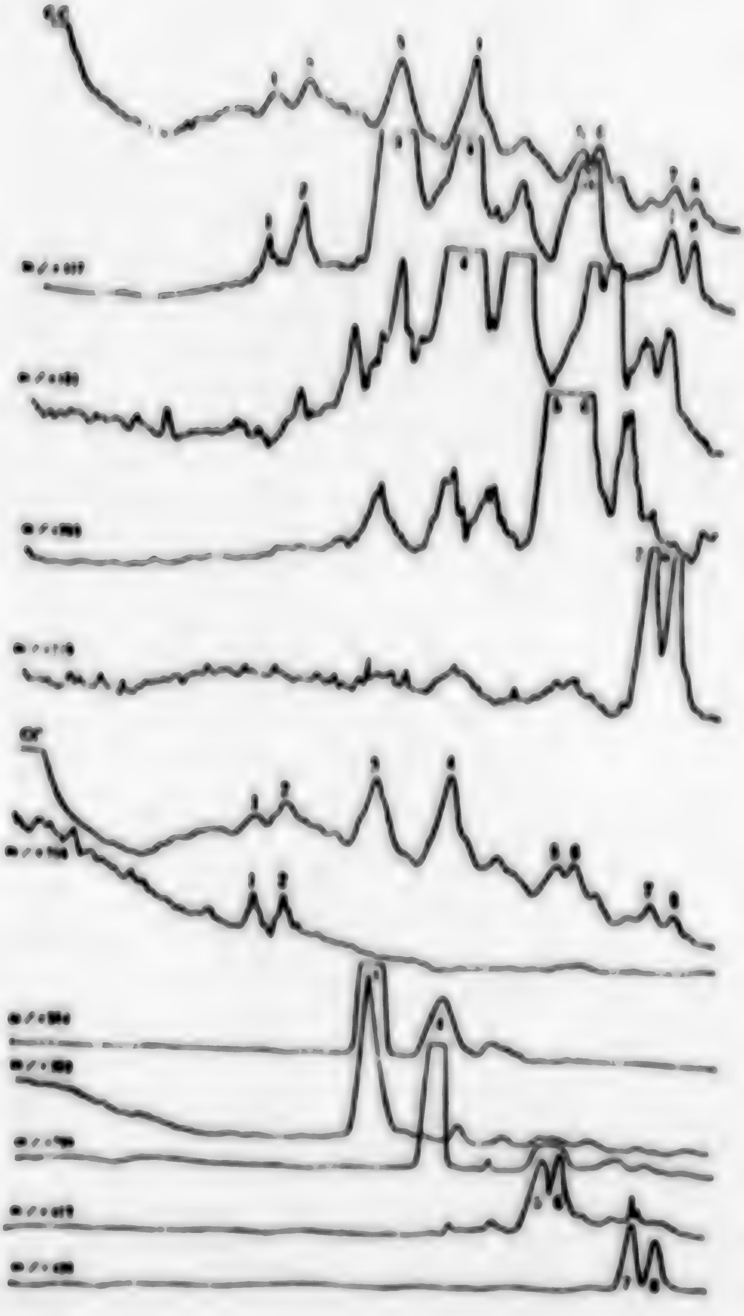

Figure 9. The chromatogram of total ionic flow and the chromatogram of mass of saturated hydrocarbons of the crude from Jin 7 Well analyzed by G_c/M_s

General Conclusion

1. A systematic method of analysis of biological marker compounds has been developed on the foundation of modern analytical techniques. It can more conveniently condense and identify some triterpane compounds. High precision liquid chromatography (HPLC) and the mass analysis of ion kinetic spectrum (MIKE) technique may be a kind of very hopeful means to separate and identify biological marker compounds.

2. The distribution of relative contents of triterpane compounds in crude oil can be used as the "fingerprints" for different crudes in different sedimentary basins. The characteristics of crudes of the Shaanxi-Gansu Ningxia Basin and the Songjiang-Liaoning Basin can be differentiated using the m/e 191 chromatogram of mass of triterpane. Organic geochemical workers believe that the crude of continental facies has a higher content of oleanane (Oleanane) and the writer has discovered the presence of such compounds in the crude of the Shaanxi-Gansu-Ningxia Basin.

3. The relationship between source rock and crude was studied at the molecular level, and the migration of crude from the source layer to the reservoir layer was studied. For example, the study of the relationship between the source rock and the crude of different strata of the Shaanxi-Gansu-Ningxia Basin shows the crude of the lower Jurassic may have possibly come from the upper Triassic.

4. The degree of maturity of crude oil can be judged comprehensively by using such parameters as the T_m/T_s value of stereoisomers of C_{21} triterpanes, the $C_{27} + C_{23} / \sum_{n-29}^{35} C_n$ value of triterpane and the content of saturated hydrocarbons. For example, the degree of maturity of the crude of the upper Triassic of the Shaanxi-Gansu-Ningxia Basin is higher than that of the crude of the lower Jurassic.

The degree of maturity of the crude of the Shaanxi-Gansu-Ningxia Basin is higher than that of the crude of the Songjiang-Liaoning Basin. The degree of maturity of the crude of the Kecan 1 Well in Xinjiang is very high. This conclusion is reasonable geologically, but the reliability of these parameters, when used to compare the degree of maturity of crudes from different basins should be studied further.

5. The "degraded" hopane type compounds discovered in the crude of the north China region may serve a function in studying the evolutionary process of petroleum in sedimentary basins. This kind of "degradation" may be an indication of the effect of microorganisms upon ordinary hopanes under special environments.

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REFERENCES

1. Tissot, B., Developments in Petroleum Geology-1, Ed, G.D. Hobson, Applied Science Publishers Ltd., 1977, London.

2. Seifert, W.K., Advances in Organic Geochemistry, 1975.

3. Ensminger, A., et al., Advances in Organic Geochemistry, 1975.

4. Pym, J.G., Rey, J.E., Smith, G.W., and Whitehead, E.A., Anal. Chem., 1975, 47, 1617.

5. Leythaeuser, D., Hallerbach, A., and Hagemann, H., Advances in Organic Geochemistry, 1975.

6. Seifert, W.K., and Moldawan, M., Geochemica et Cosmochimica Acta, 1978, 42, 77.

7. Brooks, P.W., Cordoso, J.N., Didyk, B., Eglinton, G., Humberston, M.J., and Maxwell, J.R., Advances in Organic Geochemistry, 1975.

8. Wardroper, A.M.K., et al., Geochemica et Cosmochimica Acta, 1977, 41(4), 499-510.

9. Kimble, B.J., Maxwell, J.R., Philip, R.P., Eglinton, G., Albrecht, P., Ensminger, A., Arpino, P., and Ourisson, G., Geochim. Cosmochim. Acta, 1974, 38, 1165.

10. Whitehead, E.V., Advances in Organic Geochemistry, 1973, 225.

11. McLafferty, F.W., Okamoto, J., Tsuyama, H., Nakajima, Y., Noda, T., and Major, H.W., Organic Mass Spectrometry, 1969, 2, 751.

12. Gallegos, E.J., Anal. Chem., 1976, 48, 1348.

13. Kruger, T.L., et al., Anal. Letters, 1976, 9, 533.

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PHYSICAL SCIENCES

PETROLEUM COMPOSITION, METHODS OF ANALYSIS OUTLINED

Beijing SHIYOU XUEBAO [ACTA PETROLEI SINICA] in Chinese Vol 1 No 1, Jan 80 pp 92-105

[Article by Lu Wanzhen [7120 1238 3791] and Zhang Shouzeng [1728 1108 1073] of the Institute of Petrochemical Sciences: "Analysis and Composition of Chinese Crude Oils." Footnotes are as published]

[Text] The nature of petroleum of each locality of the world is different mainly because the structure and the proportion of hydrocarbons and derivatives containing sulfur, nitrogen and metals are different.

Thus, the composition of petroleum is the most fundamental and natural factor which determines the nature of each fraction of petroleum. It is hoped that it will serve as a reference of our nation's petroleum refining technology and properties of petroleum products. To better explain the results of analysis, the methods of analysis have also been briefly described and at the same time several foreign crudes have been listed for comparison.

1. Specific Gravity of Our Nation's Crude Oil and Distribution of Each Direct Distillate Fraction

The specific gravity of crude oil is a relatively important property of crude oil. It is often used to indicate whether the petroleum is light or heavy. Because the specific gravities of various hydrocarbons are different, crude oils of the same specific gravity but of different composition will have very different direct distillate fractions and curves of true boiling points. Therefore, besides specific gravity, the distribution of each fraction in a crude oil is an important property of crude oils. Data on the distribution of each direct distillate fraction are usually obtained by three-step distillation using a theoretical plate number of 15 and a distillation tower of a return ratio of 5:1. The first step is distillation under normal pressure (initial to 200°C); the second step is distillation under reduced pressure of 10 millimeters of mercury; the third step is vacuum distillation of 2 millimeters of mercury without filler tower. The temperature in the caldron is not allowed to surpass 350°C to prevent cracking.

Table 1 lists the specific gravities and the percentage content of direct distillate fractions of 21 kinds of crude oils of our nation. To facilitate comparison, they are represented by 4 fractions, gasolines of initial distillates to 180°C, 180°C to 350°C diesel oils, 350°C to 500°C reduced pressure distillates and >500°C residues. It can be seen from the data in the table that the specific gravities of our nation's crudes are mostly above 0.86. According to the data on specific gravity of 102 exported crudes listed in the World Crude Oil Guide and published from 1976 to 1978 in the "Oil and Gas magazine," there are 44 crude oils with specific gravities >0.86. Therefore, our nation's crude oil is comparatively heavy when its specific gravity is considered by itself but it is not the heaviest.

Because our nation's crude oil contains more paraffin hydrocarbons and less aromatic hydrocarbons, it is characterized by a greater content of residual oils and a lesser content of gasolines when compared to crude oils of similar specific gravities of foreign nations. Most of the crude oils of our nation at present contain between 35 and 50 percent of residual oils. Crude oil of Daqing contains about 40 percent residual oils. Crude oil of Shengli contains between 45 and 50 percent of residual oils. Crude oil of north China contains about 40 percent of residual oils. Crude oil of Dagang contains less residual oils, or 28 percent. The table also lists the specific gravities and the contents of direct distillate fractions of four foreign crudes. The crude oil of Minahassa is also paraffin based, and thus it can be seen from the composition of gasoline and diesel fractions in the back that its gasoline and diesel compositions are very similar to those of our nation's crude oil. But its specific gravity is smaller and thus it has a smaller content of residual oils and higher content of gasolines. The specific gravity of the crude oil of Kuwait is very close to that of the crude oil of Daqing. But its retrieval of gasolines and diesels is greater than that from the Daqing crude by over 15 percent and the content of residual oils is lower by 12 percent. The specific gravity of Wilmington crude of California, U.S.A., is high (0.913), higher than the specific gravity of the mixed crude of Shengli (0.901) by 0.012, but the percentage of retrieval of gasolines is still higher than that of the crude oil of Shengli.

II. Composition of Gasolines

The analysis of the composition of gasolines in crude oil in recent years has all been done by chromatography.(1) Table 2 shows the composition of hydrocarbons in the gasoline fractions of the major crude oils of our nation. Data in Table 2 show that in our nation's major crude oils, direct distillate gasoline not only has a high content of normal paraffin hydrocarbons but also the content of cycloalkanes is mostly about 40 percent (except the direct distillate gasoline of the Yuman crude which has only a 29 percent content). Table 3 shows the result of quantitative measurements of several kinds of elementary hydrocarbons of direct

Table 1. Specific Gravities of Crude Oils of Each Oil Field and Contents of Direct Distillate Fractions

a) 编号	b) 油田名称	c) 比重 d_4^{20}	d) 汽油 初馏~180°C 重 %	e) 煤油 180~350°C 重 %	f) 蜡油 350~500°C 重 %	g) 渣油 >500°C 重 %
1	大庆([illegible])	0.8615	8.0	20.8	27.1	44.1
2	大庆([illegible])	0.8668	8.7	18.7	28.7	43.9
3	[illegible]	0.8565	7.7	20.6	31.8	39.8
4	[illegible]	0.9005	6.1	19.0	27.6	47.4
5	[illegible]	0.9026	7.3	23.3	24 (350~480°C)	45.4 (>480°C)
6	[illegible]	0.9040	1.9	14.0	28.8	55.3
7	[illegible]	0.8837	4.9	21.1	34.9	39.1
8	华北([illegible])	0.8902	1.6	21.3	33.9	43.3
9	[illegible]	0.8386	11.3	36.5	36.3	15.9
10	大港	0.8826	7.8	27.1	36.4	28.7
11	[illegible]一号	0.8860	16.6	28.5	27.0	27.9
12	[illegible]	0.8766	12.2	28.0	27.4 (350~480°C)	32.4 (>480°C)
13	[illegible]	0.8773	9.1	26.2	27.0	37.7
14	[illegible]山	0.9149	4.0	21.8	28.6 (350~480°C)	45.6 (>480°C)
15	[illegible] 1 井	0.7737	34.9	49.3	8.4 (350~420°C)	7.5 (>420°C)
16	[illegible]	0.8735	10.0	24.5	20.5	45.0
17	[illegible]	0.8682	12.3	29.2	25.2	33.3
18	[illegible]一号	0.8456	16.5	30.9	30.7	21.9
19	[illegible]	0.8818	3.6	21.5	15.8 (350~480°C)	60.2 (>480°C)
20	[illegible]	0.8042	37.9	38.0	8.0 (350~380°C)	15.6 (>380°C)
21	[illegible]一号	0.831	17.6	30.1	28.6	23.8
22	[illegible](10)	0.8685 (d_{15}^{15})	18.1	25.3	21.1	32.2
23	[illegible]	0.8031 (d_{15}^{15})	31.0	30.2	27.3	9.6
24	[illegible]	0.8483 (d_{15}^{15})	11.9	27.2	27.8	33.0
25	[illegible]	0.913	15.5 (初馏~200°C)	h) 20.0 (200~350°C)	14.5 (350~423°C)	46.0 (>423°C)

Remark: Total percentage of retrieval from foreign oil is less than 100 percent, the difference is due to the contents of C_3 and C_4.

Key to Table 1:

a) Number
b) Name of oil field
c) Specific gravity
d) Gasolines
initial - 180°C
percent of specific gravity
e) Light diesels
percent of specific gravity
f) Heavy fractions
percent of specific gravity
g) Residual oils
percent of specific gravity
h) Initial - 200°C

1) Daqing (Saerhtu)
2) Daqing (Lamadianzi)
3) Puyu
4) Shengli (mixed)
5) Shengli (Bingnan)
6) Shengli (Gudao)
7) North China (Renqiu)
8) North China (Yanling)
9) North China (Baxian)
10) Dagang
11) Northeast No 1
12) Karamay
13) Karamay low grade oil
14) Heiyoushan
15) Nanjiang Kecan No 1 well
16) Wuqi
17) Yumen (Laojinmiao)
18) Shaanxi-Gansu No 1
19) Nanyang
20) Lenghu
21) Henan No 1
22) Kuwait(13)
23) Algeria (Hassi Messaoud)
24) Indonesia (Minahassa)
25) U.S. (Wilmington, California)

distillate gasoline. It can be further seen from the analytical results of elementary hydrocarbons that our nation's various direct distillate gasoline fractions not only have a high content of cyclanes but the ratios (Table 4) of cyclohexanes/cyclopentanes are all greater than 1. As the final boiling point of gasoline rises, the content of cyclohexanes may still become greater. Thus, this kind of gasoline, after restructuring, can be more easily used to extract aromatic hydrocarbons. It can be seen from the data in Table 3 that our nation's direct distillate gasolines contain ordinary alkanes, cycloalkanes and aromatic hydrocarbons as well as several dicycloalkanes, such as dicyclo (3,3,0) octane and trans-dicyclo (4,3,0) nonane. In recent years, the presence of these dicycloalkanes in foreign crude oils was also proven. As listed in the second column of Table 4, a high content of isoalkanes with one methyl branched chain in direct distillate gasolines is the common pattern of the distribution of elementary hydrocarbons in gasolines. Therefore, when using the data in Table 3 to calculate the ratios of cycloalkanes in Table 4 and when cycloalkanes and isoalkanes are encountered in the same group and cannot be separated, they are all regarded as cycloalkanes for computational purposes, and it can be assumed that the content of isoalkanes of multiple branched chains is extremely small.

Table 2. Composition of Hydrocarbons in Gasoline Fractions (percent of specific weight)

1) [illegible]	7) [illegible] 8) [illegible]	9) [illegible]	10) [illegible]	11) [illegible]	1) [illegible]	7) [illegible] 8) [illegible]	9) [illegible]	10) [illegible]	11) [illegible]
2) [illegible] [illegible]-145°C	38	[illegible]	[illegible]	4	12) [illegible] [illegible]-200°C	50		41	9
[illegible]-200°C	57		39	4	13) [illegible] [illegible]-200°C	67		29	4
3) [illegible] [illegible]-145°C	17.[illegible]	[illegible]	[illegible]	[illegible]	14) [illegible] [illegible]-200°C	72.9		22.4	4.7
[illegible]-180°C	49		42	9	15) [illegible] 60-200°C	70		21	9
4) [illegible] [illegible]-145°C	54		[illegible]	[illegible]	16) [illegible] [illegible]-204°C	50		49	1
5) [illegible] [illegible]-145°C	19.5	[illegible]	47	12	17) [illegible] [illegible]-110°C	35		54	11
60-180°C	36		46	18	18) [illegible] 40-200°C	70		22	8
6) [illegible] [illegible]-145°C	35		54	11	19) [illegible] 45-200°C	70		21	9

Key:

1) Name of crude oil and boiling points
2) Daqing Initial
3) Shengli
4) Renqiu Initial
5) Dagang Initial
6) Liaoning No 1 Initial
7) Paraffins
8) Normal
9) Isomer
10) Cycloparaffin hydrocarbons
11) Aromatic hydrocarbons
12) Karamay Initial
13) Yumen Initial
14) Nanjiang Kecan 1 Well Initial
15) Kuwait
16) Minahassa
17) U.S. California Wilmington
18) U.S. Pennsylvania
19) Iran

Table 3. Results of Quantitative Measurements of Elementary Hydrocarbons of Various Direct Distillate Gasolines

a) [illegible]	b) [illegible]	c) [illegible] 60-145°C	d) [illegible] 60-145°C	e) [illegible] 60-145°C	f) [illegible] [illegible]-180°C	g) [illegible] [illegible]-145°C	h) [illegible] [illegible]-145°C
	1) [illegible]	—	—	—	0.85	—	0.03
[illegible]	[illegible]	—	—	—	1.79	0.02	0.71
[illegible]	[illegible]	[illegible]	0.19	0.30	5.85	1.78	1.54
[illegible]	[illegible]	[illegible]	0.39	[illegible]	6.50	[illegible]	[illegible]
[illegible]	[illegible]	0.67	0.03	—	0.16	0.08	0.08
[illegible]	[illegible]	[illegible]	0.25	0.47	0.95	0.41	0.44
[illegible]	[illegible]	1.12	0.20		0.63	—	0.19
[illegible]	[illegible]		0.77	2.56	5.08	3.14	
[illegible]	[illegible]	[illegible]	0.87	1.09	3.13	1.65	1.49
[illegible]	[illegible]	[illegible]	2.08	[illegible]	8.01	[illegible]	[illegible]

编号	化合物	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	2,2-二甲基戊烷	0.97	1.00	—	0.11	—	—
11	甲基环戊烷			4.04	4.56	3.00	2.69
12	2,4-二甲基戊烷	0.70	0.10	0.33	0.62	0.25	0.33
13	苯	1.16	0.09	0.66	0.46	0.35	0.37
14	3,3-二甲基戊烷	0.02	0.06	0.05	0.06	0.07	0.13
15	环己烷	4.75	7.57	3.16	2.60	2.83	3.74
16	2-甲基己烷	1.49	1.09	2.16	2.57	1.67	1.66
17	2,3-二甲基戊烷	0.65	0.58	1.56	1.17	1.48	2.19
18	1,1-二甲基环戊烷	0.47	0.44	0.41	0.50	—	
19	3-甲基己烷	1.83	1.75	2.57	3.08	2.44	2.73
20	1-顺-3-二甲基环戊烷	0.70	0.81	1.18	1.02	1.06	0.76
21	3-乙基戊烷	0.87	0.88	1.31	1.34	1.05	0.90
22	1-反-3-二甲基环戊烷						
23	1-反-2-二甲基环戊烷	1.65	1.29	2.24	2.50	2.76	1.81
24	正庚烷	13.83	4.47	7.21	9.24	8.85	7.49
25	2,2-二甲基己烷	0.34	0.33	0.47	—	—	0.39
26	1-顺-2-二甲基环戊烷				0.34	0.51	
27	1,1,3-三甲基环戊烷	0.47	0.62	0.90	0.49	1.05	0.28
28	甲基环己烷	11.45	9.18	7.22	5.72	7.47	7.87
29	(2,2,3,3-四甲基丁烷)						
30	2,5-二甲基己烷	0.18	0.26	0.29	0.43	0.27	0.34
31	2,4-二甲基己烷	0.19	0.32	0.38	0.36	0.34	0.38
32	乙基环戊烷	0.65	0.63	1.05	0.73	0.58	0.70
33	2,2,3-三甲基戊烷	0.02	0.04	0.03	—	—	—
34	1-反-2-顺-4-三甲基环戊烷	0.44	0.60	0.65	0.37	1.15	0.62
35	3,3-二甲基己烷	0.05	4.17	0.13	0.30	—	2.24
36	甲苯	1.05		4.54	1.05	1.19	
37	1-反-2-顺-3-三甲基环戊烷	0.60	0.70	0.06	—	1.57	—
38	2,3,4-三甲基戊烷	0.23	0.25	0.42	0.35	0.03	0.00
39	2,3,3-三甲基戊烷	0.01	0.12	0.42	—	—	0.30
40	2,3-二甲基己烷	0.22	0.34		0.26	0.35	
41	2-甲基-3-乙基戊烷	0.20	0.21	0.47	0.24	0.29	1.03
42	1,1,2-三甲基环戊烷	0.26	0.29	0.25	0.15	0.35	0.70
43	2-甲基庚烷	2.70	2.36	3.05	3.48	3.36	4.72
44	4-甲基庚烷	0.62	0.80	0.50	0.54	0.72	1.10
45	3,4-二甲基己烷	0.13	0.20	0.32	0.13	0.25	0.16
46	3-甲基庚烷(3-乙基己烷)	1.23	1.50	1.65	1.45	1.53	1.40
47	2,2,4,4-四甲基戊烷	0.06	0.15	0.74	0.36	0.10	0.13
48	1-顺-2-反-4-三甲基环戊烷						
49	3-甲基-3-乙基戊烷						
50	2,2,5-三甲基己烷	0.08	0.23	0.16		0.20	0.05
51	1-顺-2-反-3-三甲基环戊烷	0.10	0.23	0.26	0.25	—	0.23
52	1-顺-3-二甲基环己烷	3.66	4.62	2.80	2.05	4.30	3.56
53	1-反-4-二甲基环己烷				—		
54	1,1-二甲基环己烷	0.50	0.75	0.37	0.45	0.26	1.10
55	1-甲基-顺-3-乙基环戊烷	0.21	0.35	0.57	0.48	0.34	0.30
56	2,2,4-三甲基己烷	0.15	0.32	0.33	0.16	0.65	1.31
57	1-甲基-反-3-乙基环戊烷	0.77	0.85	1.12	0.87		
58	1-甲基-反-2-乙基环戊烷						

[illegible]	化 合 物	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	—	—	[illegible]	[illegible]	[illegible]	—
62	[illegible]						
63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
64	[illegible]						
65	[illegible]	—		[illegible]	[illegible]	—	—
66	[illegible]	—	[illegible]	[illegible]		—	[illegible]
67	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]
68	[illegible]						
69	[illegible]	—	—	[illegible]		—	—
70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	[illegible]						
73	[illegible]						
74	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
75	[illegible]	—	—	[illegible]	—	[illegible]	—
76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
81	[illegible]						
82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—
83	[illegible]						
84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
85	[illegible]						
86	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
87	[illegible]			—	—	—	—
88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
89	[illegible]			[illegible]		—	
90	[illegible]	—	[illegible]	[illegible]	—	[illegible]	[illegible]
91	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—
92	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
93	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
94	[illegible]				—		
95	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]
96	[illegible]				[illegible]		
97	[illegible]			[illegible]	—	[illegible]	[illegible]
98	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
99	[illegible]				[illegible]	—	
100	[illegible]		[illegible]			—	
101	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
102	[illegible]				—		
103	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
104	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
105	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]
106	[illegible]	—	[illegible]	—	—	—	—
107	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
108	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
109	[illegible]				—		
110	[illegible]	—	[illegible]	[illegible]	—	—	—
111	[illegible]	—	[illegible]	[illegible]	—	—	—
112	[illegible]	—	[illegible]	[illegible]	—	[illegible]	—
113	[illegible]	—	—	[illegible]	—	—	—
114	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]
115	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
116	[illegible]	—	[illegible]	[illegible]	—	[illegible]	—
117	[illegible]	—	[illegible]		—		—
118	[illegible]	—	—	[illegible]	—	—	—
119	[illegible]	—	[illegible]	[illegible]	—	—	—
120	[illegible]	—			—	—	—
121	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
122	[illegible]				—		
123	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]
124	[illegible]	—	[illegible]	[illegible]	—	[illegible]	
125	[illegible]	—	[illegible]	—	—	—	—
126	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
127	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
128	[illegible]						
129	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
130	[illegible]						
131	[illegible]	—	[illegible]	[illegible]		[illegible]	
132	[illegible]	—				—	
133	[illegible]		[illegible]	[illegible]		[illegible]	
134	[illegible]		—	[illegible]		[illegible]	
135	[illegible]		[illegible]	—		—	
136	[illegible]		[illegible]	[illegible]		[illegible]	
137	[illegible]		[illegible]	[illegible]		[illegible]	
138	[illegible]		[illegible]	[illegible]		—	
139	[illegible]					—	
140	[illegible]		—	[illegible]		[illegible]	
141	[illegible]		[illegible]			[illegible]	
142	[illegible]		[illegible]			[illegible]	
143	[illegible]					[illegible]	
144	[illegible]		[illegible]	[illegible]		—	
145	[illegible]					—	
146	[illegible]		[illegible]			[illegible]	
147	[illegible]					—	
148	[illegible]					—	

Key to Table 3

a. number
b. compounds
c. Daqing
d. Dagang
e. Shengli
f. Renqiu
g. Shaanxi-Gansu No 1
h. Xinjiang
i. propane and isobutane

1) n-butane
2) isopentane
3) n-pentane
4) 2,2-dimethyl butane
5) cyclopentane
6) 2,3-dimethyl butane
7) 2-methyl pentane
8) 3-methyl pentane
9) n-hexane
10) 2,2-dimethyl pentane
11) methyl cyclopentane
12) 2,4-dimethyl pentane
13) benzene
14) 3,3-dimethyl pentane
15) cyclohexane
16) 2-methyl hexane
17) 2,3-methyl pentane
18) 1,1-dimethyl cyclopentane
19) 3-methyl hexane
20) 1-cis-3-dimethyl cyclopentane
21) 3-ethyl pentane
22) 1-trans-3-dimethyl cyclopentane
23) 1-trans-2-dimethyl cyclopentane
24) n-heptane
25) 2,2-dimethyl hexane
26) 1-cis-2-dimethyl cyclopentane
27) 1,1,3-trimethyl cyclopentane
28) methyl cyclohexane
29) (2,23,3-tetramethyl butane)
30) 2,5-dimethyl hexane
31) 2,5-dimethyl hexane
32) ethyl cyclopentane
33) 2,23-trimethyl petane
34) 1-trans-2-cis-4-trimethyl cyclopentane
35) 3,3-dimethyl hexane
36) methylbenzene
37) 1-trans-2-cis-3-trimethyl cyclopentane
38) 2,3,4-trimethyl pentane
39) 2,3,3,-trimethyl pentane
40) 2,3,-dimethyl hexane
41) 2-methyl-3-ethyl pentane
42) 1,1,2-trimethyl cyclopentane
43) 2-methyl heptane
44) 4-methyl heptane
45) 3,4-dimethyl hexane
46) 3-methyl heptane (3-ethyl hexane)
47) 2,2,4,4,-tetramethyl pentane
48) 1-cis-2-trans-4-trimethyl cyclopentane
49) 3-methyl-3-ethyl pentane
50) 2,2,5-trimethyl hexane
51) 1-cis-2-trans-3-trimethyl cyclopentane
52) 1-cis-3-dimethyl cyclohexane
53) 1-trans-4-dimethyl cyclohexane
54) 1,1-dimethyl cyclohexane
55) 1-methyl-cis-3-ethyl cyclopentane
56) 2,2,4,-trimethyl hexane
57) 1-methyl-trans-3-ethyl cyclopentane
58) 1-methyl-trans-2-ethyl cyclopentane
59) 1-methyl-1-ethyl cyclopentane
60) n-octane
61) 1-trans-2-dimethyl cyclohexane
62) 1-cis-2-cis-3-trimethyl cyclopentane
63) 1-cis-4-dimethyl cyclohexane
64) 1-trans-3-dimethyl cyclohexane
65) 2,4,4,-trimethyl hexane
66) octacarbocycloalkane
67) 2,3,5-trimethyl hexane
68) isopropyl cyclopentane
69) octacarbocycloalkane
70) 2,2-dimethyl heptane
71) 2,4-dimethyl heptane
72) 2,2,3,4,-tetramethyl pentane
73) 1-methyl-cis-2-ethyl cyclopentane
74) 2-methyl-4-ethyl cyclopentane
75) x_2
76) 2,6-dimethyl heptane
77) 1-cis-2-dimethyl cyclohexane
78) n-propyl cyclopentane
79) 2,5-dimethyl heptane

80) ethyl cyclohexane
81) (ethylbenzene, 3,4,-dimethyl heptane
82) 3,3,-dimethyl heptane
83) 2,4-dimethyl-3-ethyl pentane
84) 1,1,3-trimethyl cyclohexane
85) 2,3,3-trimethyl hexane
86) 1,1,4-trimethyl cyclohexane
87) x_3
88) 2-methyl-3-ethyl hexane
89) 1-cis-3-cis-5-trimethyl cyclohexane
90) 2,3,4,-trimethyl hexane
91) nonacarbocycloalkane (pentabasic cycle)
92) p-dimethylbenzene
93) m-dimethylbenzene
94) (3,3,4-trimethylhexane)
95) 3-methyl-4-ethyl hexane
96) 2,3,-dimethyl heptane
97) x_4
98) 4-ethyl heptane
99) 3,4-dimethyl heptane
100) dicyclic (3,3,0) octane
101) 1-trans-2-trans-4-trimethyl cyclohexane
102) 1-cis-3-trans-5-trimethyl cyclohexane
103) 4-methyl octane
104) 2-methyl octane
105) 3-ethyl heptane
106) octacarbodicycloalkane
107) 3-methyl octane
108) O-dimethylbenzene
109) 2,2,4,5-tetramethyl hexane
110) 2,2,6-trimethyl heptane
111) 2,3,-dimethyl-3-ethyl pentane
112) 1-trans-2-cis-4-trimethyl cyclohexane
113) 2,2,5-trimethyl heptane
114) 1-trans-2-cis-3-trimethyl cyclohexane
115) 1-cis-2-cis-4-trimethyl cyclohexane
116) 1-cis-2-trans-4-trimethyl cyclohexane
117) nonacarbodicycle
118) x_5
119) nonacarbocycloalkane
120) 2,4,4,-trimethyl heptane
121) 1-methyl-cis-3-ethyl cyclohexane
122) 2,5,5-trimethyl heptane
123) 1-methyl-trans-4-ethyl cyclohexane
124) isopropyl benzene
125) nonacarbodicycloalkane
126) n-nonane
127) 1-methyl-trans-3-ethyl cyclohexane
128) 1-cis-2-trans-3-trimethyl cyclohexane
129) 1-cis-2-cis-3-trimethyl cyclohexane
130) 1-methyl-trans-2-ethyl cyclohexane
131) 1-methyl-cis-4-ethyl cyclohexane
132) 1-methyl-1-ethyl cyclohexane
133) trans-dicyclic-(4,3,0)-nonane
134) 2,3,5,-trimethyl heptane
135) 2,4-methyl-3-isopropyl pentane
136) isopropyl cyclohexane
137) n-propylbenzene
138) n-propyl cyclohexane
139) 1-methyl-cis-2-ethyl cyclohexane
140) nonacarbocycloalkane (hexabasic cycle)
141) 3,6-dimethyl octane
142) 3,4,4-trimethyl heptane
143) 2,6-dimethyl octane
144) 3,3,4-trimethyl heptane
145) 1-methyl-3-ethylbenzene
146) 1-methyl-4-ethylbenzene
147) 2,4,-dimethyl octane
148) 4-methyl-4-ethyl heptane

Table 4. Distribution of Cycloalkanes and Isoalkanes in Direct Distillate Gasolines

1) [illegible]	4) [illegible] 60-145°C	5) [illegible] 60-153°C	6) [illegible] 60-145°C	7) [illegible] 60-130°C	8) [illegible] 60-145°C	9) [illegible] 60-130°C
2) [illegible]	2.8	2.1	1.9	1.5	1.6	1.9
3) [illegible]	0.36	0.40	0.50	0.55	0.52	0.60

Key:

1) Name of crude oil
2) Cyclohexanes/cyclopentanes
3) $\frac{\text{Isoalkane with only one methyl branched chain}}{\text{Isoalkane}}$
4) Daqing
5) Dagang
6) Shengli
7) Renqiu
8) Shaanxi-Gansu No 1
9) Xinjiang

III. Composition of Kerosene and Diesel Oil Fractions

The analysis of the composition of the diesel oil fraction is generally by mass spectrometry.(4) Before the oil sample is subjected to mass spectrometric analysis, it is separated into aromatic hydrocarbons and hydrocarbons by column chromatography using silica gel as the adsorbent and then analyzed by mass spectrometry separately. Table 5 shows the results of analysis by mass spectrometry of the wide kerosene and diesel oil fractions of various kinds of crudes. The normal paraffins were obtained by gas chromatography. Table 5 also lists the group composition of diesel oil fractions of the crudes of California, U.S.A. and Minahassa. A comparison of the group composition of the diesel oil fraction of the various crude oils of our nation with that of the diesel oil fraction of California, U.S.A. (200-342°C) shows that the diesel oil fraction of our nation's crudes has a high content of paraffins, i.e., 23 to 41 percent are normal paraffins, (the diesel oil of Dagang contains less normal paraffins) but our nation's crudes contain less aromatic hydrocarbons and cycloparaffins. Even when compared to the diesel fraction of the crude oil of Minahassa (177-343°C) our nation's crudes still have a relatively high content of paraffins in their diesel fractions.

Table 6 shows a comparison of the contents of normal paraffins in various diesel fractions, condensation points of crude oils and wax content in crude oils. The data in the table show that because the crude oil of Shaanxi-Gansu No 1 and the crude oil of Nanjing Kecan 1 Well contain a lot of light fractions, their condensation points are relatively low even though their content of wax is not high. But the contents of normal paraffins is

Table 5. Composition of Diesel Fractions

1) 原油名称 / 2)馏分	大17)庆 145~350°C	胜18)利 145~350°C	任19)丘 145~350°C	陕甘一号 20) 轻柴油	大21)港 145~350°C	延22)岭 145~350°C	米纳哈萨23) 177~343°C	美国加州24) 200~365°C
烷 3)烃	62.6(重%)14)	58.2(重%)	65.4(重%)	60.2(重%)	44.4(重%)	75.7(重%)	48(体%)15)	2(体%)
正 4)构	41	28	30	29		37		
异 5)构	21.6	30.2	35.4	31.2		38.7		
环烷烃 6)	24.2	28.0	23.8	26.7	34.4	18.6	34.1	64
一 7)环	16.4	19.6	17.4	15.8	20.6	15.1	14.3	30
二 8)环	5.6	7.0	5.4	9.4	10.4	3.0	12.8	13
9)三环及三环以上	2.2	1.4	1.0	1.5	3.4	0.5	7.0	21
芳10)烃	13.2	18.8	10.8	13.1	21.3	5.7	17	46
一 11)环	7.0	13.5	7.1	8.6	13.2	4.0	5.0	30
二 12)环	5.3	5.0	3.4	4.3	7.5	1.6	10.0	16)10
三 13)环	0.9	0.3	0.3	0.2	0.7	0.1	2.0	(噻吩类)2

Key:
1) Name of crude oil
2) Fraction
3) Paraffins
4) Normal
5) Isomer
6) Cycloparaffins
7) Monocyclic
8) Dicyclic
9) Tricyclic and more
10) Aromatic paraffins
11) Monocyclic
12) Dicyclic
13) Tricyclic
14) (% of specific gravity)
15) (% of body)
16) Thiophenes
17) Daqing
18) Shengli
10) Renqiu
20) Shaanxi-Gansu No 1--light diesel
21) Dagang
22) Yanling
23) Minahasa
24) California, U.S.A.

Table 6. Contents of Normal Paraffins in Diesel Fractions and Contents of Wax in Crude Oils

	1) 原	油	4) 柴油馏分正构烷烃含量 (重%)		
	凝 2) 点	含3)蜡 量	200~250°C	250~300°C	300~350°C
大 庆 5)	31	26.0	38~39①	35~41②	42~43
胜 利 6)	28	14.6	12.0(200~240°C)	20.0(243~300°C)	28.0
任 丘 7)	36	22.8	30.0(180~250°C)	33.0(250~320°C)	—
大 港 8)	26	20.8	36.1	39.4	30.0
陕甘一号 9)	17	10.2	29.1	23.0	34.0
[illegible] 10)	6	6.0	54.7	53.4	47.0
[illegible] 11)	32	20	—	—	—
[illegible] 12)	-17.0	—	—	—	—

①, ②, -- Results obtained by molecular sift adsorption

Key to Table 6

1)	Crude oil	7)	Renqiu
2)	Condensation point	8)	Yanling
3)	Wax content	9)	Shaanxi-Gansu No 1
4)	Diesel Oil's Normal Paraffins (% of specific gravity)	10)	Nanjing Kecan 1 Well
5)	Daqing	11)	Minahasa
6)	Shengli	12)	Kuwait

still very high (the content of normal paraffins in the crude of Shaanxi-Gansu No 1 approaches 30 percent; the content of normal paraffins in the diesel of Kecan 1 Well surpasses 50 percent). Therefore, below 300°C, Shengli diesel oil contains slightly less normal paraffins but the content of normal paraffins in the 300°C-350°C fractions still reaches 36 percent.

Table 7. Contents of 2,6,10-tetramethyl pentadecane and 3,7,11,15-tetramethyl hexadecane in Various Diesel Oil Fractions

1)		8) 250–300°C		11) 300°C–350°C		12)
		9)	10)	9)	10)	10)
2)	6)	6.0	0.37	3.0	0.38	0.73
	7)	8.4	0.94	19.6	1.06	3.8
3)	6)	1.73	0.18	1.47	0.10	0.32
	7)	0.50	0.06	2.07	0.33	0.87
4)	6)	0.96	0.06	0.82	0.07	0.13
	7)	0.45	0.03	0.80	0.06	0.09
5)	6)	3.02	0.19	4.04	0.41	0.60
	7)	6.03	0.37	14.45	1.67	1.04

Key:

1)	Name of crude oil	8)	250-300°C fraction
2)	Yanling	9)	% of fraction (% of specific weight)
3)	Shaanxi-Gansu No 1	10)	% of Crude (% of specific weight)
4)	Daqing	11)	300°C-350°C
5)	Ren-Cang pipeline	12)	Total
6)	2,6,10,14-tetramethyl pentadecane		
7)	3,7,11,15-tetramethyl hexadecane		

In analyzing the composition of diesel oils, it has also been discovered that the crude oil of north China contains a lot of 2,6,10,14-tetramethyl pentadecane and 3,7,11,15-tetramethyl hexadecane, and the content of 3,7,11,15-tetramethyl hexadecane is high. Table 7 shows the contents of these 2 kinds of saturated polymeric isopenta-m-dienes in the 250-300°C and 300-350°C fractions of several crudes. In the crude oil of Yanling, the content of the single compound 3,7,11,15-tetramethyl hexadecane is as high as 2.3 percent (of crude) and it constitutes about 1/5 of the 300-350°C fraction. Considering the high content of 1.8 percent of 3,7,11,15-tetramethyl hexadecane in the crude of the Ren-Cang Pipeline, it can be concluded that the content of 3,7,11,15-tetramethyl hexadecane in the crude of Renqiu is very high. Written documents report that the contents of 2,6,10,14-tetramethyl pentadecane and 3,7,11,15-tetramethyl hexadecane in crudes from other places around the world are similar to the contents in Daqing crude, approximately between 0.1 and 0.5 percent.

Because our nation's crudes contain more normal paraffins, the content of elementary normal paraffins in crudes is also high. For example, the contents of C_{22} and C_{23} normal paraffins in the crude oil of Yanling are both about 1.0 percent (of crude). The contents of C_{17} and C_{18} normal paraffins in the crude oil of Daqing are all near 1 percent of crude. The contents of C_{12} and C_{13} normal paraffins in the crude oil of Kecan 1 Well are both about 3 percent. The content of C_{19} normal paraffins in the crude oil of Shaanxi-Gansu No 1 is only slightly less than 1 percent. The percentage content of these elementary hydrocarbons in the crude oil is relatively high and this is a major characteristic of our nation's crude oils.

IV. Composition of Vacuum Distillate Oils

Vacuum distillate oils can serve as raw materials for cracking. Table 8 shows the composition and the properties of the various raw material oils of crudes for cracking. The compositions of the structural groups shown in Table 8 were obtained by computation using diopter-specific gravity-molecular weight data. The content of wax was obtained by dewaxing by solution, thus it contains a small amount of oil. To facilitate comparison between the crudes of our nation and results of analysis of foreign crudes, Table 9 shows the results of analysis by mass spectrometry, and lists data for the vacuum distillate oils of Minahassa and California, U.S.A. It can be seen from the data of group composition shown in Tables 8 and 9 that our nation's crude oils, except the crude from Gudao, still contain a lot of wax in the 350-500°C fractions, their specific gravity is small, their content of sulfur is low, their content of aromatic hydrocarbons is low, and their content of saturated hydrocarbons is high. Corresponding fractions of the crude of Minahassa are relatively close in composition to those of our nation's crudes, while the composition of the crude of California, U.S.A., is very different from that of our nation's ordinary crudes, perhaps only slightly closer to the composition of the crude oil of Gudao. At present an exact comparison is difficult because of the differences in the methods of analysis.

Table 8. Composition and Properties of Raw Material Oils for Cracking

1) [illegible]	2) [illegible]	3) [illegible]	4) [illegible]	5) [illegible]	6) [illegible]	7) [illegible]①	8) [illegible]
9) [illegible]	30.38	27.0	26.4	34.9	31	28.6	28.9
10) [illegible] (°C)	350~500	350~500	350~500	350~500	350~500	350~500	350~500
11) [illegible]	44.6	27	30	47~52	30	10	8.0
12) [illegible], d_4^{20}	0.8502	0.8676	0.8892	0.8600	0.8728	0.8852	0.9261
13) [illegible]	0.016	–	0.07	0.061	—	—	—
14) [illegible]							
C_p%	70.1	62	59.5	68	68.0	53~58	38
C_n%	20.2	25	26.1	20.5	17.6	31~35	38
C_a%	9.7	13	14.4	11.5	14.5	9~12	24
R_n	1.02	1.4	1.63	1.36	1.2	1.5~2.2	3.0
R_a	0.48	0.5	0.54	0.45	0.55	0.3~0.4	0.9
15) [illegible]							
S%	0.08	0.47	0.13	0.27	0.08	0.11	1.31
N%	0.04	—	—	0.09	—	—	0.10
16) [illegible]	17) [illegible]						

① Structural Group are 350–420°C fractions

Key:

1) Origin of crude oil
2) Daqing (mixed)
3) Shengli
4) Dagang
5) Renqiu
6) Shaanxi-Gansu No 1
7) Karamay (mixed)
8) Gudao
9) Retrieval percentage (of crude, % of specific gravity)
10) Boiling range (°C)
11) Wax content (% of specific gravity)
12) Specific gravity
13) Residual carbon, % of specific gravity
14) Composition of structural group:
15) Composition of elements:
16) Source of data
17) Internal information of the Institute of Petrochemical Sciences

Table 9. Results of Analysis by Mass Spectrometry of Several Vacuum Distillate Oils

1) [illegible] / 9) [illegible]	2) [illegible] 350~400°C	3) [illegible]	4) [illegible]	5) [illegible] 350~500°C	[illegible] 6) 343~427°C	[illegible] 7) 427~510°C	8) [illegible] 343~427°C	427~510°C
10) [illegible]	62.5	42.7	31.9	38.0	53.1	44.6	2	3
11) [illegible]	34.2	34.4	36.0	40.6	36.2	45.2	44	63
12) [illegible]	17.6	5.3	10.0	10.1	17.0	23.0	9	5
13) [illegible]	8.6	4.4	10.9	8.4	6.6	10.9	9	8
14) [illegible]	4.4	5.9	7.3	8.7	12.6	11.3	8	14
15) [illegible]	3.6	16.7	7.8	9.6	—	—	10	25
16) 五环以上环烷	—	2.1	—	3.8	—	—	8	11
17) [illegible]	3.3	19.3	27.2	21.3	10.7	10.3	54	44
18) [illegible]	1.1	3.2	7.1	4.0	2.8	2.8	7	5
19) [illegible]	0.2	3.1	4.1	1.6	1.7	1.8	7	4
20) 二环烷苯	0.3	2.8	3.1	1.7	0.8	0.9	6	4
21) [illegible]	0.1	1.9	2.6	0.5	3.4	2.8	12	10
22) [illegible]	1.6	7.4	10.3	13.5	2.0	2.0	24	19
23) [illegible]	—	0.9	—	—	—	—		
24) [illegible]	0.3	0.4	0.8	0.4	—	—	4	4
25) [illegible]	—	3.2	4.2	—	—	—	—	
26) [illegible]	27) 石油化工科学研究院内部资料				[3]	[3]	[6]	

Key:

1)	Oil samples	16)	pentacycloalkane and above
2)	Kecan 1 Well	17)	total aromatic hydrocarbons
3)	Renqiu Waxy Oil	18)	alkylbenzene
4)	Shengli Waxy Oil Wei-Si Line	19)	indane
5)	Baxian/mixed oil	20)	dicycloalkylbenzene
6)	Minahassa	21)	naphthalenes
7)	Minahassa	22)	polycyclic aromatic hydrocarbons
8)	U.S.A. California	23)	undetermined
9)	Composition	24)	thiophenes
10)	Paraffin hydrocarbons	25)	Residue
11)	Total cycloparaffins	26)	Source of data
12)	monocycloalkane	27)	Internal information of the Institute of Petrochemical Sciences
13)	dicycloalkane		
14)	tricycloalkane		
15)	tetracycloalkane		

Composition of Residual Oils

Because the composition of residual oils is complex, analysis of their composition is more difficult. At the same time, the contents of each component of residual oil are related to the degree of distillation. The higher the temperature of distillation of a crude oil, the more it is stripped, the less saturated hydrocarbons there are in the residual oil, and the amounts of residue and asphalt correspondingly increase. To facilitate comparison, Table 10 shows the results of analysis of saturated hydrocarbons, aromatic hydrocarbons, residues and asphalt in residual oils of greater than 500°C of various crude oils of our nation. The methods of analysis are mostly those popular internationally. For example, asphalt was determined according to the definition issued by the International Standardization Organization (ISO) as "the component that does not contain wax, that dissolves in benzene but not in normal heptane." During analysis

Table 10. Composition of 500°C Residue Oil (percent of specif'c gravity)

原油名称 1)	饱和烃 13) % (S)	芳烃 14) % (A)	胶质 15) % (R)	沥青质 16) % (AT)	AT/R	C%	H%	C/H
大庆 2)	36.7	33.4	29.9	<0.1	<0.03	86.8	12.6	6.9
胜利 3)	21.4	31.3	45.7	1.6	0.035	85.8	11.6	7.4
任丘 4)	22.6	24.3	53.1	<0.1	<0.02	85.45	12.08	7.07
孤岛 5)	11.0	34.2	46.8	8.0	0.17	85.9	11.8	7.4
陕甘一号 6)	41.4	31.4	27.2	0	0	—	—	
大港 7)	—	—	—	—	—	86.46	12.48	6.9
河南二号 8)	34.3	33.7	32.0	0	0	86.8	12.4	7.0
米纳斯 9)	57.6	29.8	11.0	1.4	0.13	86.3	12.4	7.0
科威特 10)	16.9	52.8	24.0	6.3	0.26	83.6	10.3	8.1
委内瑞拉 11)	7.8	34.0	41.8	16.4	0.39	82.6	10.4	7.9
国外减压道路沥青① 一般组成 12)	5~15	30~45	30~45	5~20	—	—	—	—

① Asphalt for road covering produced by vacuum distillation of residual oils of foreign countries

Key:

1) Name of crude
2) Daqing
3) Shengli
4) Renqiu
5) Gudao
6) Shaanxi-Gansu No 1
7) Dagang
8) Henan No 2
9) Minahassa
10) Kuwait
11) Venezuela
12) General composition of foreign asphalt① produced by vacuum distillation
13) Saturated hydrocarbons
14) Aromatic hydrocarbons
15) Residue
16) Asphalt

an amount of normal heptane 30 times the amount of sample oil was added to precipitate the asphalt which was measured quantitatively. After separating the asphalt, saturated hydrocarbons, aromatic hydrocarbons and residues were analyzed by adsorptive chromatography. The adsorbent used was aluminum oxide with 1 percent water. The chromatographic column was kept at constant temperature by circulation of 50°C water. The ratio of aluminum oxide to oil sample was 40:1 to 100:1. Petroleum leve was used to wash out the saturated hydrocarbons, and then benzene was used to wash out the aromatic hydrocarbons. Finally, a mixed solution of ethanol-benzene was used to remove adhesion of the residue. After distilling away the solvents of each fraction, the fraction was dried and the percentage content of each fraction was calculated.

The data in Table 10 show the content of asphalt in most of the residual oils of our nation (by the normal heptane method) is very small, only the residual oil of Gudao contains 8 percent asphalt, while the asphalt content of all other residual oils is less than 2 percent. Compared to foreign residual oils of similar contents of residues, the ratio between asphalt and residue of the residual oil of our nation is very small. The major components of our nation's residual oils are saturated hydrocarbons, aromatic hydrocarbons and residue. In the residual oils of Daqing and Henan (Wenliu), these three components are almost evenly distributed, each constituting about one-third. The amount of saturated hydrocarbons in the residual oils of Shengli and Renqiu is less than that in the residual oil of Daqing. The amount of saturated hydrocarbons in the residual oil of Gudao is even less. The amount of residue in the residual oils of Shengli, Renqiu and Gudao is very high, constituting almost half of the residual oils. The residual oil of Shaanxi-Gansu No 1 is characterized by a highest amount of saturated hydrocarbons and slightly less residue. Figure 1 shows the contents of the components of various residual oils.

At the same time, the content of carbon (C percent), the content of hydrogen (H percent) and the ratio of carbon to hydrogen show the content of hydrogen in our nation's residual oils of each large oilfield is higher than that in ordinary foreign heavy residual oils. The carbon/hydrogen value and the asphalt value of our nation's residual oils are low. This characteristic may be beneficial to deep processing of our nation's crude.

VI. Contents of Nonhydrocarbons in Our Nation's Crude Oils

The two elements of carbon and hydrogen constitute between 95 and 99.5 percent of the content of petroleum while other elements such as sulfur, nitrogen, oxygen and small amounts of phosphorous, arsenic, vanadium and nickel constitute between 0.5 and 5 percent. But all of these noncarbon and nonhydrogen elements exist as derivatives of hydrocarbons in petroleum, and the percentage of the compounds containing these elements is therefore much larger. Their properties are very different from pure hydrocarbons. Thus, they exert a great influence upon the properties and processing of

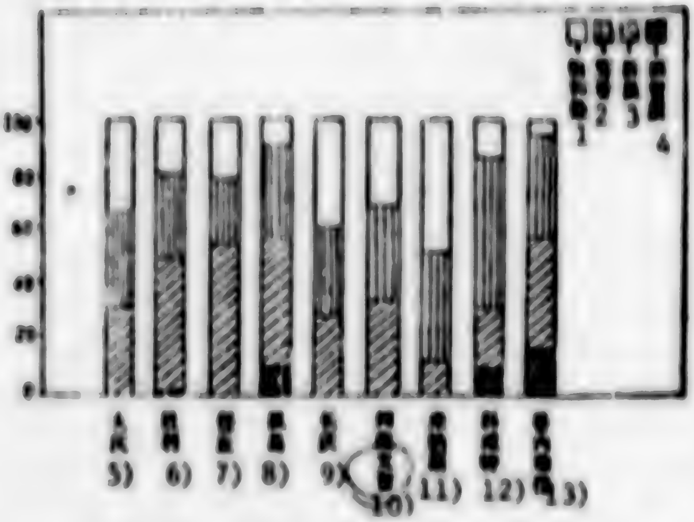

Figure 1. Contents of the four components of residual oils

Key:
1) Saturated hydrocarbons
2) Aromatic hydrocarbons
3) Residues
4) Asphalt
5) Daqing
6) Shengli
7) Renqiu
8) Gudao
9) Chengqing
10) Henan Wenliu
11) Minahassa
12) Kuwait
13) Venezuela

petroleum. The contents of these noncarbon and nonhydrogen elements in crude oil have always been the center of attention of petroleum researchers.

The classical wet chemical method such as the burner tube for fixing sulfur and the Kjeldahl method to fix nitrogen are still important means to determine these noncarbon and nonhydrogen elements. But as various processing techniques develop, various noncarbon and nonhydrogen elements of low content in oils must be accurately and rapidly determined. Under many situations, the original wet chemical method cannot satisfy the need. At present, the methods being used more frequently are the microcoulomb method (to determine sulfur and nitrogen) of atomic absorption or colorimetry (to determine metallic content).

Table II lists the contents of noncarbon and nonhydrogen elements in our nation's crudes. At the same time it lists the highest and the lowest contents of such elements in crude oils of various places of the world for comparison. It can be seen from the data that the content of sulfur of most of the crude oils of our nation is very low, almost approaching the

Table 11. Contents of Various Noncarbon and Nonhydrogen Elements in Crude Oils

1) [illegible]	16) [illegible] ([illegible]%)	17) [illegible] ([illegible]%)	18) [illegible] (ppm)	19) [illegible] (ppm)	20) [illegible] (ppm)	21) [illegible] (ppm)	22) [illegible] (ppb)
2) [illegible]	0.12	0.13	<0.08	2.3	0.7	0.03	2800
3) [illegible]	0.80	0.41	1	26			
4) [illegible]	1.8~2.0	0.5	0.8	14~21	10	0.4	
5) [illegible]	0.3	0.24					
6) [illegible]	0.15	0.23	<1	18.5		0.6	
7) [illegible]	0.3	0.31	0.7	15	1.0		0.220
8) [illegible]	0.1	0.3	<0.02	10.6	0.8	0.46	
9) [illegible]	0.1	0.73	<0.6	15.0	8	0.7	
10) [illegible]	1.33~ 2.0	0.38~ 0.30	0.4	12.0	<1	0.6	
11) [illegible]	0.47	0.4	0.4	12	60	2	
			(←	23) [illegible]	→	→)	
12) [illegible]	0.1		<0.1	1.3	0.4	0.3	
13) [illegible]	0.05	0.067	<1	~2			
14) [illegible][7]	5.5	0.77	230	150			1620[illegible]
	24) ([illegible])	25) ([illegible])	26) ([illegible])	27) ([illegible])			28) ([illegible])
15) [illegible][7]	0.02	0.02	0.1	<1			<0.01

Key:

1)	Crude oil	15)	Lowest content of the world's crudes (7)
2)	Daqing	16)	Sulfur
3)	Shengli 101 Reservoir	17)	Fluorine
4)	Gudao	18)	Vanadium
5)	Bingnan	19)	Nickel
6)	Dagang	20)	Iron
7)	Renqiu	21)	Lead
8)	Yumen	22)	Arsenic
9)	Karamay	23)	Yan 24 wells
10)	Wuqi	24)	Venezuela
11)	Yanling mixed crude	25)	California, U.S.A.
12)	Baxian mixed crude	26)	Venezuela
13)	Shaanxi-Gansu No 1	27)	California, U.S.A.
14)	Highest content of the world's crudes (7)	28)	California, U.S.A.

lowest sulfur content of the world's crude. Even the crude oil of our nation that has a relatively high content of sulfur (Guado and Jiang Han crudes) has only about two-fifths of the highest sulfur content of the world's crudes. One document (1) reported that of the 104 exported world crudes, 20 have a sulfur content higher or equal to 2.0 percent. But our nation's crudes have a slightly higher nitrogen content. Some have gathered data on the nitrogen content of 210 crudes.(7) Of these, there are only 31 crudes that have a nitrogen content higher than 0.3 percent, but most of our nation's crudes contain over 0.3 percent of nitrogen.

The content of vanadium in our nation's crude oils is very low, but the content of nickel is slightly higher. It can be seen from Table 12 that the ratio of nickel and vanadium in our nation's crude oils is much higher than that of foreign crudes. The influence of nickel is thus greater than that of vanadium. In addition, the content of arsenic in the crude oil of Daqing is five times higher than that of the crude oil of Louisiana, U.S.A. (probably the crude containing the highest amount of arsenic in the world). This is rare.

Table 12. Ratio of Nickel Vanadium in Crude Oils

1) [illegible]	16) [illegible] (ppm)	17) [illegible] (ppm)	18) [illegible]
2) [illegible]	<0.08	3.1	>38
3) [illegible]	1	26	26
4) [illegible]	0.8	21	26.3
5) [illegible]	<1	18.5	>18.5
6) [illegible]	0.7	15	21.43
7) [illegible]	<0.02	18.8	>940
8) [illegible]	<0.4	13.8	>34
9) [illegible]	0.4	12.0	30
10) [illegible]	<0.1	1.3	>13
11) [illegible](1)	<0.4	10	>25
12) [illegible]	183	18	0.098
13) Lagomedio			
14) [illegible]	31	9.6	0.31
15) [illegible]	53.7	22.6	0.42

Key:

1)	Name of crude oil	10)	Baxian
2)	Daqing	11)	Minahassa(1)
3)	Shengli	12)	Venezuela
4)	Gudao	13)	Lagomedio
5)	Dagang	14)	Kuwait
6)	Renqiu	15)	Romashki
7)	Yumen	16)	Vanadium
8)	Karamay	17)	nickel
9)	Wuqi	18)	nickel/vanadium

VII. Characteristics of Our Nation's Crude Oils

Summarizing the various compositional data described above, it can be seen that most of the crudes of our nation possess the following characteristics:

--The percentage of retrieval of light oils is low, the retrieval percentage of raw material oils for cracking and residual oils is high.

--The crude oils contain more paraffins and the content of normal paraffins is high. Thus, the wax content is high and at the same time the content of aromatic hydrocarbons is low and the ratio of hydrogen/carbon is high. The content of cycloalkanes in gasolines is high.

--The content of asphalt in residual oils is low, and the ratio of asphalt/residue is small.

--The content of sulfur is low but the nitrogen content is high.

--The content of vanadium is low, the content of nickel is medium, and the ratio of nickel/vanadium is high.

In addition to the above types of crude oils, our nation also has small amounts of crude oils with rather special properties. These can be divided into two types.

The first type is light crude such as the crudes of Nanjiang Kecan 1 Well, Basian, Shaanxi-Gansu No 1, Lenghu and Henan (Wenliu).

The second type is the crude of low condensation point, high specific gravity and high content of residue, such as the low condensation crudes of Heiyoushan and Karamay No 3, the Yangsanmu crude of Dagang and the Gudao crude of Shengli. These are suitable for the production of low condensation products and asphalt. Figure 2 shows the correlation curve between the boiling points and densities of the fractions produced from the several kinds of crudes mentioned above. Figure 3 shows the correlation curve between the boiling points and the condensation points of the fractions of the crudes described above. The diagrams also show the correlation curves of each fraction of the crude of Daqing for comparison.

(This article was received on May 22, 1979)

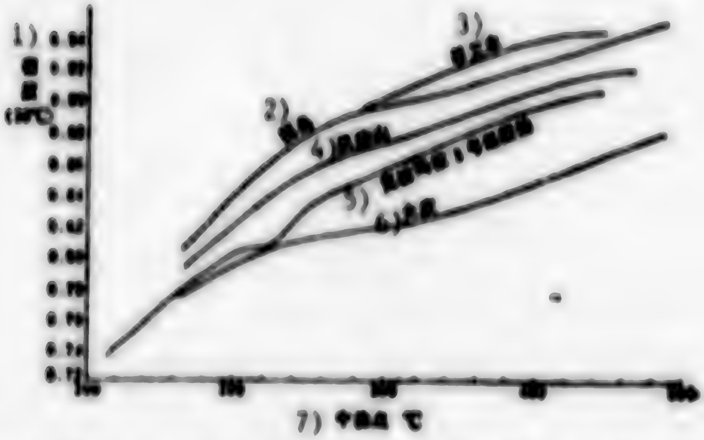

Figure 2. Correlation graph between middle boiling point and density of each fraction of crudes

Key:
1) Density
2) Gudao
3) Yangsanmu
4) Heiyoushan
5) Karamay No 3 low condensation crude
6) Daqing
7) middle boiling point

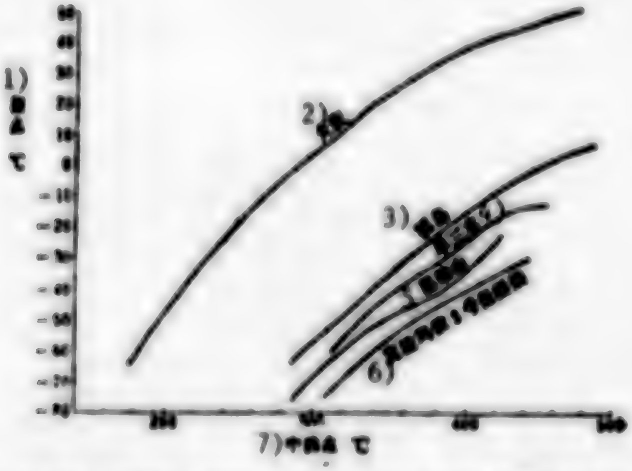

Figure 3. Correlation graph between middle boiling point and condensation points of each fraction of crudes

Key:
1) Condensation point
2) Daqing
3) Gudao
4) Yangsanmu
5) Heiyoushan
6) Karamay No 3 low condensation crude
7) middle boiling point

REFERENCES

1. "Information on Scientific Techniques of Oil and Gas Processing," Scientific Techniques Information Research Institute of the Ministry of Petroleum, 1978 No 4.

2. "Compilation of Information on Evaluation of Crude Oils" (1) (2), 1974, 1976.

3. "Minao Crude Oil Processing Manual," California Research Co, 1963.

4. "Mass Spectrometry of the Composition of Hydrocarbons in Kerosene and Diesel Oils," Petroleum Refining, 7, 39 (1979).

5. Anal.Chem, 39, 1833 (1967).

6. Anal. Chem, 34 49 (1962).

7. "Analysis of Crude Oils from 470 Important Oilfields in the United States" U.S. Bureau of Mines, Report of investigation No 5376, 1957.

8. "Kuwait Crude Oil Processing Manual," 1957.

9. "The Role of Trace Metals in Petroleum," T.F. Yeu, 1975.

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ATMOSPHERIC BOUNDARY LAYER PHYSICS RESEARCH DESCRIBED

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[Article by Zhou Mingyu [0719 2494 3558], Zhang Xifu [1728 6932 4395], Li Xingsheng [2621 5281 3932] and Lu Naiping [0712 0035 1627], Institute of Atmospheric Physics, Chinese Academy of Sciences: "Advances in Research on Atmospheric Boundary Layer Physics"]

[Text] Atmospheric boundary layer physics is a branch of atmospheric physics. In the 30 years since the country was founded, and particularly in the last decade, atmospheric boundary layer physics has undergone considerable development in connection with work on atmospheric pollution and the progress of atmospheric physics, and has made some satisfying progress. Below we concisely summarize a few aspects of its development.

1. Atmospheric Boundary Layer Sounding and Experimental Methods

Atmospheric boundary layer sounding methods can be classified as direct and indirect. The direct sounding methods introduce sensors directly into the boundary layers in various ways to conduct soundings; the methods currently most in use in our country are: steel towers, tethered balloons (tethered dirigibles), lower-atmosphere sounding instruments, aircraft, and diffusion experiments with dispersing of tracers. Indirect methods being studied and used in our country are acoustic radar and laser radar.

The use of special weather towers or other types of steel towers to conduct soundings of atmospheric layers or to conduct observations of atmospheric pollution is a relatively direct and effective method. It has the advantages of being continuous, synchronous, all-weather and multipurpose. The data accuracy is high, and the disadvantage is that the altitude of the soundings is limited by the height of the tower. Currently this country and others generally use steel towers to investigate the structure, turbulence and characteristics and diffusion laws of atmospheric boundary layers and to compare observations from direct sounding instruments and indirect techniques. In the autumn of 1976, the Institute of Atmospheric Physics set up in Beijing a 320-meter atmospheric tower (see Fig 1) [not reproduced]. The tower is a mast consisting of an equilateral triangular framework, with the sensors mounted at 15 different levels. In order to decrease the tower's resistance to airflow, Hong Zhongxiang et al[1] carried out simulation experiments in a wind tunnel and decided to attach two movable suspended arms at each level, with the length of the arms preferably being at least 1.5 times the cross-sectional width of the tower.

Li Xingsheng, Zheng Dazhou et al[2] designed an automatic surface layer gradient remote sensing system, which fully automatically measures the signals from the tower. Currently wind speed and direction, humidity difference and absolute humidity, vertical velocity, humidity and supersonic pulse windspeed and temperature instruments are mounted on the tower. The windspeed instrument requires a minimum velocity of 0.4 m/sec, and measures a maximum velocity of 50 m/sec with an accuracy of ±2 percent. The output voltage is a linear function of the actual wind velocity; the wind direction instrument goes into action with winds of 0.04 m/sec, and is accurate to within ±5°.[3] The temperature drop and absolute humidity meter both use imbalance bridges, and their accuracy is better than 0.1°C.[4] The supersonic pulse windpseed and temperature instrument uses the pulse time difference method. Its advantage is that it is easy to eliminate noise and reflections of the supersonic pulses from neighboring objects, and the range is rather broad, from 0.01 to 30 m/sec. Wind velocity is determined to within 3 percent and the maximum resolution is 0.01 m/sec.[5] The signal from the sensors on the tower is transmitted by shielded cable to two data-processing stations. One of them sends the average field signal to a program controlled sampling device which use an electrical voltage-balancing device to record the measurements in profile form. The other uses a mobile detector, modulus transfer unit to enter the instantaneous signal value in a DJS-130 minicomputer for processing.

Tethered balloons (or dirigibles) and low-level atmospheric sounding devices are the tools which our country has used most extensively in atmospheric boundary layer and atmospheric pollution measurements. Currently they are used mostly to measure the temperature distribution with altitude. The advantages of these methods are: they are easy to move about, the measurement altitude is rather high, and the cost is low. In order to avoid breakage of the measurement cable by entanglement with the balloon tether or the effects of static electricity in the vicinity of the balloon and the tether, radio remote sensing is the most reliable. Currently, single temperature measurement remote sensing systems are in relatively broad use in atmospheric pollution field surveys. We mainly use tethered dirigibles in simultaneous multipoint temperature determinations, in addition to which they are also used as carriers of the tracers to be scattered in atmospheric diffusion experiments. The disadvantage of using tethered balloons in atmospheric boundary layer soundings is that they are limited by weather conditions, and are particularly unsuitable for use in rainy and windy weather.

The use of aircraft for measurement of atmospheric boundary layers is just beginning in our country. Currently Pan Naixian et al[6] are using aircraft radiosonde meteorological instruments for fast automatic sensing of atmospheric temperature, pressure, wind velocity and humidity. The temperature determination accuracy is within 0.1°C, the barometric pressure determination is within 2 mbar; the instruments can perform the above four measurements in 1 second.

The use of 3-dimensional photography to measure manmade smoke trails is a method which has been used fairly universally in our country during the last 10 years for short-range diffusion experiments.[16] Recently such phosphorent agents as indium, sulfur dioxide and sulfur hexafluoride have been dispersed as tracers for atmospheric diffusion experiments.

The use of laser radar for remote sensing of smoke plume density is a method that has been developed in the last 10 years. Because the components and spectra of manmade smoke clouds are very stable, in the early 1970's the Institute of Atmospheric Physics used laser radar in experiments on manmade smoke clouds; using ratios of backscatter coefficient and extinction coefficient to density which had been determined in advance, they measured seven absolute smoke density levels, and determined in the field the spatial distribution of the density of a dissipating manmade smoke cloud over 3 kilometers in stable weather conditions,[7] providing data relevant to diffusion of factory pollutants and the overall development situation. Dealing with the problem of pollutant diffusion in the Shijingshan [4258 2529 1472] area, Sun Jingqun et al[8, 9] used a smoke plume that was released stably and measured the vertical distribution of relative density, thereby obtaining the atmospheric diffusion constant for smoke over 4 kilometers in the downwind direction for different weather conditions.

Acoustic radar is a new and effective active remote sensing method in atmospheric boundary layer remote sensing which began to be developed in the late 1960's. In the early 1970's, the Acoustic Radar Group[10] of this country's Institute of Atmospheric Physics experimentally developed a single-point acoustic radar sounding system. The basic principle of acoustic radar is that the acoustic radar antenna emits a fixed-frequency acoustic pulse into the atmosphere, and because nonuniformities in atmospheric windspeed and temperature can result in scattering of the acoustic wave, it is possible to determine the nature of atmospheric scattering of the acoustic waves and thus to find out the spatial distribution and time change of such important meteorological factors as windspeed, temperature, and turbulence characteristics. The single-point acoustic radar system consists of three elements: an antenna, an emitter and a receiver. The antenna includes an electroacoustic rotator, a parabolic reflector and a sound baffle. The focal length of the parabolic reflector is 50 cm and its radius is 1.5 m. Fig 2 [not reproduced] shows the acoustic radar antenna. The emitter consists of an audio frequency signal source, an emitter switch, a power amplifier, a low-level suppressor and a transceiver transformer. The receiver consists of a signal channel, a program control unit and recording equipment.

The main parameters of the acoustic radar are shown in Table 1. When the equipment was used for field observations, the intensity of the returning wave was tested against temperature data from a tethered balloon, with results that were in agreement. Soundings were also conducted on the formation and dispersion of temperature inversions in the atmosphere, their wave motion, the breakup of gravity waves, the altitude of mixing layers, and heat convection and multilayer inversions, providing good results.[11] Fig 3 [not reproduced] shows an actual reading of a multilayer inversion and inversion wave movement in the Beijing region between 0137 and 0537 on 24 May 1977.

Table 1. Main Characteristics of the Acoustic Radar

Emitted power	100 W electric power
Pulse width	100 milliseconds
Pulse repetition rate	3 sec, 4 sec, 5 sec
Maximum range	about 1000 meters
Emission frequency	1588 Hz
Antenna diameter	1.5 meters
Antenna beam directionality	8° (half power)
Receiver bandwith	40 Hz
Receiver sensitivity	6.1 mV/icrobar

In addition, Zhou Mingyu et al[12] have proposed some principles for correlation wind measurement using the returning wave signal from single-point acoustic radar, and have conducted comparisons with small ballooon wind measurements, with the results more or less in agreement.

2. Laws of Distribution of Meteorological Factors in the Boundary Layer, and Their Turbulence Characteristics

This country's meteorologists did some exploratory work and investigations into the laws of distribution of meteorological factors in the near-earth layer in the 1950's and early 1960's.[13-15] This work was mainly discussed in terms of the theory of similarity. Theoretical calculations and actual data were compared, and in qualitative terms they were in agreement, but in quantitative terms they were not fully in accord.

In the late 1960's, the Institute of Atmospheric Physics began to carry on work on atmospheric pollution, and accordingly it carried out a good deal of observational and analytical work in mountain regions and the Beijing suburbs on near-earth layer wind velocity and temperature profiles.[16] At night in mountainous regions, the near-earth layer above several dozen meters generally had a strong temperature inversion center, with its strength sometimes reaching 1 degree per 10 meters or higher. Because of the complexity of mountain topography, above 200 or 300 meters there were generally many temperature inversion centers, whose intensity generally decreased with increasing altitude. The wind field structure in mountain regions was also more complex than in the plains, and the wind fields in the near-earth atmospheric layer were primarily topographic winds, with gradient winds above them. Topographic winds included primarily slope winds, mountain valley winds (including reverse mountain valley winds) and large-scale topographic winds (large-scale mountain valley winds and large-scale slope winds, with the latter also called mountain-area plains winds).

In mountain areas, the near-earth layer windspeed profile generally was more complex than on the plains. Because there were considerable valley winds in the valleys, and the wind flow basically followed the valleys, when there was neutral stratification, below several dozen meters the windspeed profiles generally followed a logarithmic relationship. The roughness value z_0 in mountain regions was greater than in the plains, and was equal to 1/5 to 1/2 the vegetation altitude, while in the plains z_0 was equal to 1/10 to 1/4 the vegetation altitude. When the stratification was nonneutral, the windspeed profiles were much more complex in the mountains than in the plains.

When investigating distribution patterns of winds over uneven surfaces Zhao Deshan et al[17] analyzed data from observations made atop an 80-meter tower in the western suburbs of Beijing, determining that given a surface of uniform roughness, in neutral stratification the average wind velocity profile below 77 meters followed a complete logarithmic distribution relationship. With stable stratification, when the stability coefficient was $0.028 \leq R_i \leq 0.69$, it agreed with the logarithmic-linear law, so that the stratification correction expression $\varphi\left(\frac{z}{L}\right)$ can be written as

$$\varphi\left(\frac{z}{L}\right) = 1 + \beta\frac{z}{L} \tag{1}$$

where $\varphi\left(\frac{z}{L}\right) = \frac{\kappa z}{u_*}\frac{du}{dz}$,

Here L is the Monin-Obukhov length, K is the Karman constant, and β is a constant which depends on R_i as follows

$$\beta = 0.35R_i^{-0.9}, \tag{2}$$

With unstable stratification,

$$\varphi\left(\frac{z}{L}\right) = \left(1 - \gamma\frac{z}{L}\right)^{\alpha}, \tag{3}$$

where the coefficient $\gamma = 16$, and α varies with the stability. When the stratification is weakly unstable, $\alpha = -1/4$; when it is moderately unstable $\alpha = -1/3$; and when it is highly unstable $\alpha = -0.4$. With nonuniform surface conditions, because the surface roughness z_0 changes abruptly, with all types of stratification the windspeed profiles all show a "turning point." the empirical formula for calculating the turning point is

$$\frac{h}{z_0} = \left[0.6 + 0.01 \ln \frac{z_0'}{z_0} + \ln (1 - \alpha_0 R_i)^{0.1}\right]\left(\frac{x}{z_0}\right)^{0.8} \tag{4}$$

When $0.03 \leq R_i \leq 0.12$, $\alpha_0 = 8$; when $-1.04 \leq R_i < 0$, $\alpha_0 = 0.8$; here x is the horizontal distance between the observation point and the line at which there is an abrupt transition between two surface roughness values.

Yan Kaiwei et al[18] have investigated the laws of distribution of windspeed, temperature and humidity in the layer just above a water surface. Because on a water surface there is a wave effect, the water surface characteristics are relatively complex. With neutral stratification and relatively strong windblown waves, below 80 cm the wind velocity profile has a turning point, so that after wave-height correction it is in accordance with the logarithmic profile rule. With nonneutral stratification, the stratification correction formula $\varphi(R_i)$ can be expressed as follows:

$$\varphi(R_i) = \begin{cases} -0.417 \dfrac{R_i}{\sqrt{|R_i|}} + 0.40 & R_i < 0 \\ -0.278 \dfrac{R_i}{\sqrt{|R_i|}} + 0.40 & R_i > 0. \end{cases} \tag{5}$$

The temperature profile pattern at the water surface is basically the same as over the ground. When the stability is in the range $-1 < R_i < -0.07$, it follows the relationship $\frac{dT}{dz} \propto z^{-4/3}$. In addition, an analysis was made of the similarity of the temperature, humidity and wind profiles, and the results showed that the temperature profile and humidity profile resembled each other to some extent, but they did not resemble the windspeed profile.

In the last decade, a good deal of research has been done in this country on boundary layer turbulence. Chen Jiayi et al[19] used observations of windspeed modulus fluctuations to analyze turbulence structure at altitudes of 100 to 1,470 meters, and found that the probability distribution of windspeed modulus fluctuations was nearly on a normal curve. The velocity field structure formula $D(\gamma)$ for small-scale turbulence vortex areas satisfies the relationship $D(\gamma) \propto \gamma^P$, where P generally is close to 2/3 but shows a tendency to increase as stability increases. Below several hundred meters, the maximum scale at which the structure function follows the "2/3 law" increases with altitude, and generally is several times as great as the altitude. In locations higher than several hundred meters, the maximum scale at which the 2/3 law is followed is lower than the altitude, but there is no systematic variation with altitude. In addition, they found that the turbulent energy dispersion rate shows sharp fluctuations.

Wen Jingsong et al[20] used a platinum wire resistor temperature pulse instrument to observe the temperature fluctuation field at 1.7 meters and above; on analyzing their observational data they found that the temperature pulse spectrum everywhere showed discontinuities, expressed as a series of discontinuous pulse excitations which could be divided into "base state stable," "base-state unstable" and "base-state large fluctuation" types. The time discontinuity of turbulence also indicated the nonuniformity of the spatial structure of the turbulence field.

In recent years the Acoustic Radar Group of the Institute of Atmospheric Physics has used acoustic radar observation data to analyze boundary layer atmospheric turbulence characteristics and small-scale structure coefficients. Lu Naiping et al[21] analyzed the space-averaged temperature pulse spectrum $\phi_T(K_0)$ in scattering bodies at different altitudes (where K_0 is the wave number corresponding to the acoustic radar emission frequency). The analysis revealed that in the atmospheric boundary layer $\phi_T(K_0)$ is a random quantity which has a normal skew distribution, and also satisfies normal logarithmic distribution. From an analysis of the frequency spectrum of $\phi_T(K_0)$ it was found that in the spectral region from 10^{-1} to $3 \cdot 10^4$ sec^{-1} there was an energy peak region with a very steep transition band between it and the high-frequency region. On a medium scale, for either stable or unstable stratification, there is generally cyclic activity lasting from several minutes to 10-odd minutes.

Chen Yanjuan et al[22] used acoustic radar sounding data to calculate the turbulent structure constant. The calculation results showed that C_T^2 had rather large fluctuations over time. Analysis of the time-altitude profile of C_T^2 revealed that under stable conditions it had a stratified structure, but its values had no clear relationship to altitude. In clear weather, with light winds and convective conditions the distribution of C_T^2 showed a longitudinal vertical structure, and its change with altitude was nearly regular. Under unstable conditions, the atmospheric turbulence structure constant showed a change with altitude of the type $C_T^2(z) \propto z^{-4/3}$, $C_V^2(z) \propto a + bz^{-4/3}$ (where C_V^2 is the wind velocity structure constant, and a and b are constants).

The above observational phenomena make it clear that the temperature pulse spectrum and the windspeed pulse spectrum both show fluctuations. Accordingly, we cannot view the temperature structure coefficient C_T^2 as a constant: it too is a variable. This also makes it clear that the vortical energy dispersion rate ε which determines C_T^2 and the temperature nonuniformity smoothing rate N are both variables. They inevitably affect the temperature structure formula, the basis of the "rule of 2/3." Accordingly Zhou Mingyu[23] discussed a revision of the temperature structure formula resulting from having both and N being variables.

Both ε and N are taken as average values in a sphere whose radius is the distance r between observation points M_1 and M_2

$$\bar{\varepsilon}(M_1, M_2) = \frac{6}{\pi r^3}\int_{V_{M_1M_2}} \varepsilon dV \tag{6}$$

$$\bar{N}(M_1, M_2) = \frac{6}{\pi r^3}\int_{V_{M_1M_2}} N dV \tag{7}$$

On the basis of observations, $\bar{\varepsilon}$ and $\bar{N}$ both follow the log normal distribution, i.e.

$$\bar{\varepsilon} = \varepsilon_0 e^{\eta_1}, \quad \bar{N} = N_0 e^{\eta_2}$$

where ε_0 and N_0 are the geometric means of $\bar{\varepsilon}$ and $\bar{N}$, and η_1 and η_2 are random variables, which follow a normal distribution given by the following coefficients:

$$\left.\begin{array}{ll} \bar{\eta}_1 = \langle\eta_1\rangle = 0 & D(\eta_1) = \langle\eta_1^2\rangle = \beta_1 \\ \bar{\eta}_2 = \langle\eta_2\rangle = 0 & D(\eta_2) = \langle\eta_2^2\rangle = \beta_2 \end{array}\right\} \tag{8}$$

where β_1 and β_2 are deviations.

In horizontally uniform turbulence fields where the atmospheric stratification is close to normal, we can consider that $\bar{\varepsilon}$ and $\bar{N}$ are mutually independent. Accordingly we can obtain

$$\langle[T(M_2) - T(M_1)]^2\rangle = a^2 \frac{\bar{N}}{\bar{\varepsilon}^{1/3}} \gamma^{2/3}[1 + M_1^2(\gamma)]^{2/9} \tag{9}$$

where the brackets indicate mathematical expectation, a is a constant, and $M_1(\gamma) = \sigma_\varepsilon/\bar{\varepsilon}$. We can see from formula (1) that the new temperature structure formula which uses $\bar{\varepsilon}$ and $\bar{N}$ as variables has an additional correction factor $M_1^2(\gamma)]^{2/9}$, beyond the rule of 2/3, and the correction factor is related only to $\bar{\varepsilon}$ and not to $\bar{N}$. An estimate of the correction factor was made on the basis of the actual observed values of the turbulent energy dissipation rate spectrum: equation (9) "corrects" the rule of 2/3 only on a small scale. When γ = 0.01 m, the correction factor is 1.37; when γ = 10 m, it equals 1.

Liu Zhenxin, Chen Jiayi et al have investigated the atmospheric turbulence spectrum. Liu Zhenxing[24] proposed the dimensionless quantity R_i to describe turbulence characteristics (R_i = D/v), where D is the turbulent viscosity coefficient and v is the dynamic viscosity coefficient), and used this dimensionless quantity to determine the general form of the energy transfer function applicable to each area of the spectrum, then solved the turbulence spectrum formula, obtaining a universal solution of the turbulence spectrum function E(k):

$$E(k) = \frac{Nk^{-1}}{\left[\left(\frac{k_c}{k_y}\right)^{2/3} + \left(\frac{k}{k_y}\right)^{2/3}\right]} \exp\left\{ -3\alpha\left(\left[\left(\frac{k_c}{k_y}\right)^{2/3} + \left(\frac{k}{k_y}\right)^{2/3}\right]^{2} \right.\right.$$
$$\left.\left. - 2\left(\frac{k_c}{k_y}\right)^{2/3}\left[\left(\frac{k_c}{k_y}\right)^{2/3} + \left(\frac{k}{k_y}\right)^{2/3}\right] + \left(\frac{k_c}{k_y}\right)^{2}\ln\left[\left(\frac{k_c}{k_y}\right)^{2/3} + \left(\frac{k}{k_y}\right)^{2/3}\right]\right)\right\} \qquad (10)$$

where N is a constant, $N = \alpha(\varepsilon\gamma)^{1/2}$, α is the Kolmogorov constant, k is the wave number, $k_y = \left(\frac{\varepsilon}{\gamma^3}\right)^{1/4}$, $k/c = \left(\frac{\varepsilon}{D^3}\right)^{1/4}$. On the basis of experimental results, $k_c/k_y = 10^{-4}$. For subinertial regions where $\left(10^{-4} < \frac{k}{k_y} < 5 \times 10^{-2}\right)$,

$$E(k) = \alpha(\varepsilon\gamma)^{1/2}k_y^{2/3}k^{-5/3} = \alpha\varepsilon^{2/3}k^{-5/3}, \qquad (11)$$

which is entirely in agreement with Kolmogorov's and Obukov's results.

In a similar manner, the microparticle density turbulence spectrum related to the atmospheric temperature field and atmospheric pollution was obtained. When the above theory was compared with actual measurement results, agreement was rather good.

Chen Jiayi[25] used the theory of similarity to obtain a semiempirical formula for the one-dimensional wind velocity turbulence spectrum $\bar{S}_{11}(f)$

$$\bar{S}_{11}(f) = C_1 \Big/ \left(1 + \frac{f}{f_{01}}\right)^{5/3}, \quad C_1 = \frac{2}{3}\,\frac{\overline{U'^2}}{U_*^2}\cdot\frac{1}{f_{01}}, \qquad (12)$$

where $f = nz/\bar{U}$ is the dimensionless frequency, $f_{01} = n_{01}z/\bar{U}$ is the dimensionless characteristic frequency of longitudinal large-scale turbulence, and U_* is the friction velocity. Formula (12) is in good agreement with experimental data.

In addition, Chen Jiayi used dimensional analysis to infer from the turbulent equilibrium formula the relation between turbulence energy and the low-altitude atmospheric microscopic conditions:

$$\sqrt{\overline{U_i'^2}} = (\alpha_i k f_{0i})^{-1/3}[\varphi(\zeta) - \zeta]^{1/3}, \qquad (13)$$

where U_i is the windspeed component, α_1 is a proportionality constant, and $\zeta = z/L$ where L is the Monin-Obukhov length. Comparison of formula (13) with observational data indicates that the calculated value for the vertical turbulence energy is in good agreement with observed data. The agreement with the horizontal turbulent energy is somewhat poorer.

Questions of lower-atmospheric heat transfer generally have been discussed in terms of the heat conduction formula with an unvarying background field. But many observations indicate that the stratification of the lower atmosphere changes over time, and when the vertical convection is rather strong, stratification changes rapidly. On the basis of this fact, Zhou Mingyu[26] discussed the interaction of background stratification (γ) and heat transfer, and neglecting the step functions and pressure perturbations he set up heat transfer functions which allowed for this interaction.

$$\begin{cases} \dfrac{\partial^2 \overline{w'T'}}{\partial t^2} = \overline{w'^2}\,\dfrac{\partial^2 \overline{w'T'}}{\partial z^2} - 4\beta(\gamma_a - \gamma)\,\overline{w'T'} \\[2ex] \dfrac{\partial(\gamma - \gamma_a)}{\partial t} = \dfrac{\partial^2 \overline{w'T'}}{\partial z^2} \\[2ex] \dfrac{\partial \overline{w'^2}}{\partial t} = 2\beta\overline{w'T'} \end{cases} \tag{14}$$

where $\beta = \frac{g}{T}$, g is the gravitational constant, and γ_a is the dry adiabatic gradient. He used the above formulas in a numerical computation, whose results indicated that interaction of heat transfer and stratification have a strong effect on the former, and in unstable conditions the heat flux greatly exceeds that for stable conditions. The results for vertical heat transfer were that local atmospheric stratification shows clear changes, and ultimately tends toward neutral stratification.

3. Atmospheric Diffusion

Experimental and theoretical studies of atmospheric diffusion in this country began in the 1960's and currently the Institute of Atmospheric Physics and the Nanking University Department of Meteorology have carried out separate atmospheric diffusion experiments in the northeast and northwest of the country. However, the reason that atmospheric diffusion work has been able to develop rapidly has primarily been industrial pollution problems. Between the late 1960's and the early 1970's, the Institute of Atmospheric Physics and Institute of Geography, Chinese Academy of Sciences, the Weather Bureau and design departments have carried out boundary layer observations and diffusion experiments in more than 10 mountain valley areas and 7 provinces and municipalities, which provided scientific data for the task of safety protection in setting up plants in mountain regions, and summarized meteorological characteristics and diffusion laws, for mountain areas.

Diffusion in mountain regions is more complex than in plains regions in two main respects. One is that under the influence of topography (dynamic and thermodynamic) the temperature and wine fields of the mountain regions are very complex, so that the pollutant transport process is complex and hard to describe quantitatively. The other reason is that in mountain regions turbulence is not only stronger than in the plains, but is also highly nonuniform, and nonlinear effects between different dimensions are pronounced, so that the diffusion process is difficult to handle.

On the basis of observations of the atmospheric boundary layer in mountain regions, and also of smoke screen tracks and shapes, we summarized the relationship between pollutant transport and meteorological conditions,[16] which has the following characteristics:

1. Inversion centers (vertical gradient maxima) have an inhibiting effect on vertical exchange. At night pollutants flow between the surface and the inversion centers (or between two inversion centers), causing a pronounced increase in pollutants downwind.

2. The complex vertical structure of wind fields causes pollutants at different altitudes to take different paths, and in certain small areas there are possibilities for circulation.

3. Airflows across mountains produce lee eddies or subsiding airflow in mountain valleys, pollutants cannot form complete smoke trails, and they are hard to describe by means of models.

4. Downslope winds, mountain-crossing currents and subsiding valley winds cause smoke trails to slope downward so that they may even touch the ground. As the maximum density at the ground increases, its location becomes much closer than calculation results from plains area models.

5. With light winds, variations in wind direction result in local density accumulation processes.

Because atmospheric turbulence is stronger in mountain regions than in plains regions with the same degree of stability, mountainous regions' diffusion coefficients are greater than those in plains areas. Three-dimensional photography of smoke screens and laser radar observation data were used to obtain the diffusion constant σ_y for mountain regions, which was larger than or close to the value for plains regions in other countries, while σ_z was much greater for mountain regions than for plains regions.[27] An experiment comparing mountain and plains regions near Beijing found that the values of σ_y and σ_z for plains areas were roughly in agreement with foreign values for plains areas, while σ_y for mountain regions was 1.9-2.5 times as great as in the plains and σ_z was 2.5 times as great for mountain regions as for plains.

As the problem of urban atmospheric pollution was raised in the early 1970's, atmospheric diffusion research turned from investigation of the laws of short-range transport and diffusion of atmospheric pollution to investigation of medium-distance transport and diffusion laws for the complex urban boundary layer and investigation of multisource atmospheric pollution models.[28-30]

Dynamic and thermodynamic effects of buildings in industrial regions and cities have produced characteristic boundary layer structure and diffusion patterns. In order to set up a multi-source atmospheric pollution model, In the middle 1970's the Institute of Atmospheric Physics, Beijing University and other organizations carried out observations of atmospheric boundary layer structure and atmospheric diffusion patterns in the Shijingshan region near Beijing. Photographic methods and direct laser radar measurement of industrial smoke were used to obtain the atmospheric diffusion coefficient.[8] In addition, wind-direction pulse data recorded on a tower in an agricultural area near a factory area were used to calculate the atmospheric diffusion coefficient for a distance of 4-5 kilometers.[31] The atmospheric diffusion coefficient for the factory district was one stability level higher than for a plains area, and that for an agricultural area was only half a stability level higher. This indicates very marked unevenness. Accordingly, it is very important to take account of unevenness. Moreover, because of topographic and heat island effects, with light winds the air flow develops a curved radiating pattern, and accordingly account must be taken of horizontal flow fields. As a result, Zhang Xifu et al made use of a smoke mass model.[29-30] They used an interpolation formula with wind reading data from eight stations to calculate the wind direction and velocity for all points in the network. For the smoke mass they used the wind directions and velocities for the grid points and the diffusion coefficient movement and the diffusion for the atmospheric stability level of the moment. The time interval τ must satisfy the relationship $\tau = e/U$ (where e is the spacing of the grid and U is the wind velocity). In addition they also derived an area-source formula for pollution produced by residential areas themselves, and the calculated density was in rather good agreement with observations. For higher winds, they worked out a continuous point-source model which took account of vertical changes in wind direction and velocity. The results of calculations with the model provided data for evaluation of atmospheric quality in the area and comprehensive treatment, and for reasonable siting and emission standards for new factories.

In addition, Laboratory No 4 of the Institute of Atmospheric Physics[16] used wind direction pulse data from mountain regions to calculate the atmospheric diffusion coefficient σ_y, and used laser radar to obtain an observed value of σ_y. It found that the ratio β of the Lagrang and Euler time scales in mountain regions was an average of 5.4, larger than in plains areas ($\beta = 4$), while β was not related to the atmospheric stability level or wind velocity, and within a certain distance (400-700) meters it was also independent of distance. But the Atmospheric Experimental Technology Group[27] used a similar method in a mountain region near Beijing and found a value $\beta = 2$, lower than for a plains region. It is generally believed that β is inversely proportional to the turbulence, and since mountain turbulence is high, β should be small. The fact that we obtain different values for β in different mountain regions indicates that the factors determining this quantity in mountain regions are complex and require further research.

Luo Xiuqing[32] has carried out research on the problem of turbulent diffusion involving vertical advection and diffusion particle settling effects. He discussed diffusion with a nonconstant, continuous point source and with absorption effects at the surface, obtaining calculation results which agreed with observations.

Deng Yuzhen et al[33] have carried out a numerical simulation of density accumulation processes in mountain regions with light winds, discovering that the equilibrium time is related to wind velocity, atmospheric stability and changes in wind direction. The equilibrium time is between 20 minutes and 1 hour, which is close to the observed value of 40 minutes.

In addition, Laboratory No 4 of the Institute of Atmospheric Physics[16] took the field equations for effluent flow as the starting point in investigating the laws governing the rise of smoke plumes emitted by smokestacks, and obtained a group of conservation formulas describing the average efflux flow characteristics. The maximum altitude of a smoke plume calculated from the theoretical model was in relatively good agreement with observational results. The patterns of axial density dilution of smoke plumes also can be calculated, but there are no suitable data for verification.

BIBLIOGRAPHY

1. Hong Zhongxiang [3163 6988 4382]; Cao Jilu; and Yin Tong. "Wind Tunnel Study of Wind Measurement Errors Produced by a Meteorological Tower," 1978 (unpublished).

2. Li Xingsheng [2621 5281 3932]; Zheng Dazhou, Zhang Weihua; Wu Jialin; Zhu Jin et al. "The Automatic Remote Sensing System of the 320-Meter Meteorological Tower," 1977 (unpublished).

3. Zheng Dazhou [6774 6671 3166]; Zheng Shuzhen; Liao De; and Lu Shuichang. "Physical Characteristics of the Gradient Anemometer," 1977 (unpublished).

4. Li Xingsheng, and Yang Baozhong. "A High-Precision Temperature Measurement Method," DAQI KEXUE, No 2, 1979.

5. Zhou Leyi [0719 2867 5030]; Zhao Yijun; Li Dexin et al. "A Supersonic Pulse Anemometer —Thermometer," 1978 (unpublished).

6. Pan Naixian [3382 0035 0341], and Tao Shanchang. "An Aircraft Radiosonde Meteorological Instrument," NEIJING DAXUE XUEBAO, No 3, 1978, pp 20-27.

7. "Laser Smoke Measurement and the Use of Lasers in Meteorological Measurements," in "Zhongguo kexueyuan daqi wuli Yanjiusuo jikan [Collection of Institute of Atmospheric Physics, CAS]," No 1, 1973.

8. Sun Jingqun [1327 2529 5028]; Jin Huishu; and Hu Yuliang. "Laser Measurement of the Atmospheric Diffusion Coefficient," DAQI KEXUE, No 1, 1977.

9. Sun Jingqun; Tao Lijun; and Wu Shaoming. "Laser Remote Sensing of Smoke Plume Density. Investigation of Problems of Atmospheric Remote Sensing," in "Collection of Institute of Atmospheric Physics, CAS," No 5, Kexue Publishers, 1977.

10. Acoustic Radar Group, Institute of Atmospheric Physics. "Single-Point Acoustic Radar and Measurement of Atmospheric Boundary Layers," DAQI KEXUE, No 1, 1976.

11. Chou Ming-yu; Fan Hsi-an; Wu Nai-ping; Chu Shao-hou; and Chen Yen-chuan. "Acoustic Radar and Remote Sensing in the Boundary Layer of the Atmosphere," in "Proceedings of the 12th International Symposium on Remote Sensing of the Environment," 1978, pp 535-546.

12. Zhou Mingyu, and Qu Shaohou. "Wind Determination by the Acoustic Radar Correlation Method," DAQI KEXUE, No 2, 1979.

13. Su Congxian [5685 1783 0341]. "Turbulence in the Surface Layer of the Stratified Atmosphere," QIXIANG XUEBAO, No 29, 1958, pp 73-82.

14. Liu Zhenxing [0491 2182 5281]. "The Regularity of Turbulent Mixing in the Atmospheric Surface Layer," KEXUE JILU, No 2, 1958, pp 152-158.

15. Pu Peimin [3450 1014 3046]. "Turbulent Motion in the Atmospheric Surface Layer with Different Temperature Stratification Conditions," QIXIANG XUEBAO, No 34, 1964, pp 211-224.

16. Institute of Atmospheric Physics. "Shanqu kongqi wuran yu quxiang [Air Pollution and Meteorology of Mountain Regions]," Kexue Publishers, 1978.

17. Zhao Deshan [6392 1795 1472]; Peng Xian'an; and Hong Zhongxiang. "Experimental Study of Windspeed Profiles in the Near-Surface Layer Over an Uneven Surface," (unpublished).

18. Yan Kaiwei [0917 7030 0251]; Lu Naiping; and Jing Ronglin. "Temperature, Humidity and Wind Profile Patterns in the Near-Surface Layer Above Water," (unpublished).

19. Chen Jiayi [7115 1367 1355]; Tan Xin; and Dong Suzhen. "Turbulent Microstructure in the Lower Troposphere," QIXIANG XUEBAO, Vol 33, No 2, 1963.

20. Wen Jingsong [3306 2529 1529]; Zeng Zongyong; and Ma Chengsheng. "Noncontinuity of Turbulence and the Kolmogorov Turbulence Theory," DAQI KEXUE, No 1, 1978.

21. Lu Naiping [0712 0035 1627]; Fan Xi'an; Chen Jingnan; Zheng Yueming; and Zhou Mingyu. "Acoustic Radar Sounding of the Statistical Charateristics of Atmospheric Turbulence in the Boundary Layer," (unpublished).

22. Chen Yanjuan [7115 3508 3197]; Fan Jinhua et al. "Acoustic Radar Sounding of Lower-Atmosphere Turbulence Structure Coefficients," (unpublished).

23. Zhou Mingyu [0719 2494 3558]. "Basic Questions of Temperature Field Structure in Atmospheric Turbulence Fields," (unpublished).

24. Liu Zhenxing. "The Atmospheric Turbulence Spectrum and Related Atmospheric Pollution Questions," DAQI KEXUE, No 2, 1978, pp 219-229.

25. Chen Jiayi. "Lower-Atmosphere Turbulence Spectra and Energy Patterns," KEXUE TONGBAO, No 7, 1966, pp 334-336.

26. Zhou Mingyu. "Initial Research on Lower-Atmosphere Convective Heat Transfer," QIXIANG XUEBAO, No 3, 1963, pp 290-296.

27. Atmospheric Experimental Technology Group. "Preliminary Analysis of the Results of an Atmospheric Diffusion Experiment in a Mountain Area," DAQI KEXUE, No 1, 1977.

28. Laboratory No 4, Institute of Atmospheric Physics. "Research in Dynamic Patterns of Atmospheric Pollution in the Shijingshan Region," in "Beijing Xijiao huanjung zhiliang pingjia wenji [Collected Articles on Evaluation of Environmental Quality in Beijing's Western Suburbs]," (forthcoming].

29. Laboratory No 4, Institute of Atmospheric Physics. "Use of the Multisource Atmospheric Pollution Model in Environmental Programs," HUANJING KEXUE No 1, 1976.

30. Zhang Xifu [1728 6932 4395] et al. "The Multisource Atmospheric Pollution Model," in "Huanjing kexue yangji ji qi jinzhan [Environmental Science Research and Its Progress]," Kexue Publishers (forthcoming).

31. Central Weather Bureau et al. "An Atmospheric Diffusion Experiment Under Complex Topographic Conditions: A Summation of the Beijing Radio Station Atmospheric Experiment," 1977.

32. Luo Xiuqing [5012 4423 0615]. "Chaotic Flow Dissipation of a Continuous Point Source with Vertical Advection Transport," QIXIANG XUEBAO, No 3, 1963.

33. [illegible]ng Yuzhen [6772 3768 3791]; Zou Xiaoheng; and Zhang Xifu. "A Numerical Model of Density Accumulation Processes in Mountain Regions With Light Wind," in "Environmental Science Research and Its Progress," Kexue Publishers (forthcoming).

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APPLIED SCIENCES

EARTH TIDE STUDIES DESCRIBED

Beijing DIQIU WULI XUEBAO [ACTA GEOPHYSICA SINICA] in Chinese Vol 23 No 1, Jan 80 pp 103-115

[Article by Fang Jun [2455 0193], Institute of Geodesy and Geophysics, Chinese Academy of Sciences: "Earth Tide Studies: Their Relationship to Earth Science, Astronomy and Space Science." Footnotes are as published]

[Text] ABSTRACT. The study of earth tides is extremely important because they are the only phenomenon in geophysics the forces producing which can be determined in advance and which can be experimentally verified. Since the first International Geophysical Year in 1957, great progress has been made in this field. This article gives a brief introduction to the subject, its importance in modern science and its achievements.

1. Introduction

Every object on the earth's surface is subject to two forces: the attractive force of the entire earth and the centrifugal force resulting from the rotation imparted by the earth. The resultant of the two is called the "gravitational force." The gravitational force points toward the earth's interior and we call its direction the "vertical." If there is no interference from external forces, the gravity field over the entire earth would be steady-state. The external forces in question come primarily from the attraction of celestial bodies or changes in the gravitational field resulting from shifting of the material in the earth's interior. The attractive force of the moon and sun is an attractive force that is relatively clearly understood and can be calculated mathematically. Because the sun and moon are not equally distant from all points on the earth, points on the earth are subject to differing gravitational forces. We define the difference between the gravitational force exerted on the earth's surface by the sun and moon and that exerted on the center of the earth as the "tidal force," because it is this force which produces tidal phenomena on the earth. Although this tidal force is very small, it can produce evident changes on the earth's surface, since it can cause the gravitational force on the earth's surface to vary by about

0.2 mgal, while the vertical can deviate by as much as 5/10,000 of a second of arc. These changes can all be directly measured by modern precision instruments; the most evident of them are the periodic ocean tides, the tidal phenomena with which mankind is familiar. The tidal force can be calculated very precisely from the masses of celestial bodies (primarily the sun and moon, since the effect of the other planets is extremely small and can be neglected), their distances from the earth and their position relative to the observation point. This is a reliable standard which nature has provided for earth research.

The question of whether this attractive force causes similar effects in the solid earth, i.e. tidal phenomena, involves the question of the earth's rigidity. In the 19th Century, French astronomers were already aware that latitude changes which they observed were closely related to tides. Almost half a century later, in 1863, the Englishman Kelvin discovered from an analysis of tides that the biperiodic tidal component Mf was only 2/3 of the theoretical value. He recognized that this loss of a third was because the land at sea level also rose. This was the beginning of the study of earth tides. After 18 more years, in 1891, the American S. C. Chandler discovered that the period of precession which he observed was much longer than the natural precession period inferred by Euler; it was equal not to 305 days, but to about 14 months. This is the well known "Chandler period." Later, the astronomer S. Newcomb referred this expansion of the precessional period to earth tides. Accordingly, the study of earth tides has been intimately connected with precession since its beginning[9].

2. The Love Numbers

We described above the changes in the form of the earth resulting from the attractive force on the earth's surface from the sun and moon, which show that the earth is not a completely rigid body, but has a certain elasticity. The current problem is how big an earth tide effect it can produce. We know that the tital force is the derivative of the tidal potential. It causes a readjustment of the material inside the earth, resulting in an additional potential V. This is proportional to the tidal potential W, so that we can write

$$V = kW. \qquad (1)$$

where k is a constant which is determined by the rigidity and density of the material inside the earth. Furthermore, owing to the tidal potential W, the earth's surface rises. The amplitude of the rise is

$$u_r = hW/g. \qquad (2)$$

This means that theoretically the rise is W/g multiplied by h. Here h is another coefficient which likewise is determined by the rigidity and density of the earth. These two coefficients are called the Love numbers[7]. Based on the Kelvin hypothesis, if the earth is a uniform noncompressible sphere,

$$k = \frac{3f}{2f+1}, \quad h = \frac{5f}{2f+1},$$

where

$$f = \frac{g\delta a}{19\mu}.$$

Here a and g are the radius of the earth and the gravitational acceleration at the surface; and δ and μ are the uniform density and rigidity. Accordingly, we obtain the relationship k = 0.6h.

If we take $\delta = 5.52$, $a = 6.37 \times 10^8$ cm, and $g = 98$ cm/sec^2, and assume that the density is the same as that of steel, namely $\mu = 8.19 \times 10^{11}$ cgs units, then k = 0.46 and h = 0.77. If we take $\mu = 1.5 \times 10^{12}$ cgs units, then k = 0.29 and h = 0.48. This is relatively close to the observed figures.

Moreover, there is a third elasticity constant l, which was derived by the Japanese Shida in 1912. This is the ratio of the horizontal displacement of the earth's surface caused by the tidal force to the theoretical value, i.e. the horizontal displacement in the direction of S:

$$u_s = l\,\frac{\partial W}{\partial s}. \tag{3a}$$

If we place our instruments in the north-south and east-west directions, then the north-south and east-west displacements will be

$$u_{NS} = \frac{l}{g}\,\frac{\partial W}{\partial \theta}, \quad u_{EW} = \frac{l}{g}\cdot\frac{1}{\sin\theta}\cdot\frac{\partial W}{\partial \lambda}, \tag{3b}$$

where θ is the colatitude, λ is the longitude and W is the gravitational potential. For the uniform earth described above, l = 0.3h.

Kelvin's assumption described above is an extremely crude earth model. The real earth is naturally much more complex. At the beginning of this century, G. Herglotz developed Kelvin's theory by assuming that the density and rigidity of the earth's interior are a function of radius, but he still assumed that the earth's interior is incompressible. From this he derived a sixth-order differential equation, which he could only solve under certain special conditions. The density and rigidity distributions which he used were based on an extremely simple earth model calculated from the Roche formula. At that time, because knowledge of the structure of the earth was extremely superficial, and computational tools were extremely backward, a relatively complex earth model could not be used for research.

In 1950, the Japanese H. Takeuchi[17] used a density distribution which followed the seismologist Bullen and a distribution of the modulus of elasticity inferred from the velocities of earthquake waves, and assumed that the earth was compressible, thereby extending Herglotz's theory. He successfully used numerical integration to solve the equations. He used a total of six models.

Two of them assumed a liquid center ($\mu = 0$) and came relatively close to observed values. He believed that the rigidity at the core could not exceed 10^9-10^{10} cgs units. Subsequently Jeffries and Molodenskiy conducted complex, detailed investigations[3, 14]. The latter made calculations for 16 models, of which seven took $\mu = 0$. The results were all relatively close to the actual values. The greater the assumed rigidity, the greater the discrepancies in the data. One problem worth noting is the ratio of k to h. In Kelvin's uniform theory, the ratio is 3/5. But as calculated from the models described above, it was quite close to 0.5. This had already been pointed out in 1950 by the Belgian P. Melchior.

3. Observation of Earth Tides

In contrast to ℓ, which can be measured with an extensometer, the abovementioned Love numbers k and h cannot be directly measured. The changes produced by the tidal force at the earth's surface include the following: 1. rise and fall of the earth's surface; 2. tilting of the earth's surface; 3. changes in the gravitational acceleration at the earth's surface; 4. horizontal displacement of the surface.

On the basis of formulas (1) and (2) in the preceding section, we can see that the ratio of the fluctuations in the real (elastic) earth's surface to those in the theoretical (rigid) earth's surface is

$$H_{obs} = (1 + k - h)H_{theor}$$

where H_{obs}=V/g and H_{theor}=W/g. From this we can see that

$$\gamma = \frac{\text{observed surface fluctuation}}{\text{theoretical surface fluctuation}} = 1 + k - h$$

Theoretically the rise and fall of the earth's surface can be inferred from the difference between the value read off the scale at tidal measurement stations and the theoretical value. But the tidal rise and fall does not follow the equilibrium tidal theory, so that tidal station readings cannot be used to infer γ. Of course, some long-period tidal components are another story, but it is still difficult to obtain precise values. However, because the tilting of the earth's crust is the ratio of the horizontal derivative of the attractive potential to the gravitational force, we can use the tilting of the earth's surface to calculate γ, i.e.

$$\gamma = \frac{\text{observed tilt of the earth's surface}}{\text{theoretical tilt}} = 1 + k - h \qquad (4)$$

The tilting of the earth's surface can be divided into north-south and east-west observations. Because h is greater than k, γ is less than 1.

Tilting of the earth's crust can be measured by a clinometer, such as a horizontal pendulum. Currently the most accurate and stable horizontal pendulum which can be used in earth tide determinations is the V-M (Verbaandert-Melchior) quartz horizontal pendulum of the Royal Belgian Observatory. Its accuracy is within 0.0002". But it must be installed in a mountain cave 40-50 meters underground to carry out measurements, so as to avoid interference.

Currently one gravimeter used in determination of earth tides is the DS series of the Askania plant (West Germany). Starting with the GS-11, they have all been usable in earth tide measurements. Currently the company is producing the GS-25. Its accuracy is within several microgals. Other gravimeters include the American Lacoste-Romberg gravimeter and the geodynamic gravimeter. The ET model of the former (made specially for earth tide observation) has been accuracy within 1/10 of a microgal or better.

The ratio of the gravity change observed at the earth's surface to the theoretical value is designated by δ and is related to the Love numbers k and h as follows:

$$\delta = \frac{\text{observed gravity change}}{\text{theoretical gravity change}} = 1 + h = 3/2k; \qquad (5)$$

δ is always greater than 1.

If we install a horizontal pendulum and gravimeter in an observatory, by long-term observation and analysis we can determine the two coefficients γ and δ. By substituting these into equations (4) and (5), we can determine the two Love numbers h and k. As to the third elasticity constant ℓ, we can use an extensometer to determine directly the horizontal displacement of the earth's surface (in the north-south and east-west directions), and then compare them with the theoretical value to determine ℓ (equation (3b)). At present a relatively reliable value is $\ell = 0.05$, which was observed in 1952 by Sassa and Ozawa.

Another way of deriving ℓ is to derive it directly from long-term astronomical observations (latitude and radius changes). The changes in the vertical observed in an observatory are fundamentally different from surface tilting observed by means of a horizontal pendulum. The latter is tilting produced by the tidal force acting on the surface of the earth, while the former are tilting of an artificial horizontal surface (spirit level or mercury surface) relative to fixed star coordinates, and thus tilting of the actual vertical of the observation point relative to the instantaneous rotation axis of the earth. The ratio of the actual observed latitude (or radius) changes to the theoretical value is designated by Λ, which is related to 1 and k by the relationship

$$\Lambda = \frac{\text{actual observed longitude and latitude change}}{\text{theoretical longitude and latitude change}} = 1 + k - 1 \qquad (6)$$

4. Expansion of the Tidal Potential: A Theoretical Calculation

A celestial body with a mass m at a distance R from the earth (distance between centers) exerts at a given observation point on the earth a tidal force equal to

$$W = \frac{Gm}{R} \sum_{n=2}^{\infty} \left(\frac{\rho}{R}\right)^n P_n(\cos\theta). \qquad (7)$$

where G is the gravitational constant, ρ is the radius vector of the observation station, $P_n(\cos\theta)$ is the n-th order Legendre polynominal, and θ is the vertical angle of the observation station. In formula (7) only the second order term has a large effect and can be measured. Although the third order term is very small, in certain investigations it must be used, but it is even more difficult to observe. For the sake of simplicity, here we will only discuss the second-order term. Accordingly, we can write equation (7) as

$$W_2 = \frac{3}{4} Gm \frac{\rho^2}{R^3}\left(2\cos^2\theta - \frac{2}{3}\right) = \left[\frac{3}{4} GM \frac{a^2}{c^3}\left(\frac{m}{M}\right)\right]\left(\frac{\rho}{a}\right)^2\left(\frac{c}{R}\right)^3\left(2\cos^2\theta - \frac{2}{3}\right). \qquad (8)$$

We have extracted a pure constant (the term in brackets). Here GM = 3.986003×10^{20} cm^3/sec^2, c is the average radius of the lunar or solar orbit, and a is the average radius of the earth. For the moon a/c = 1/60.27 and for the sun, it is 1/23,400; m/M is the ratio of the masses of the earth and the celestial body, which is 1/81.45 for the moon and 333,432 for the sun. Accordingly the constant in brackets is G = 26206 for the moon and should be multiplied by 0.46051 for the sun. The quantity ρ/a is the ratio of the station radius vector to the average earth radius; it is a function of position. The quantity c/R is the ratio of the average distance from the celestial body to the earth to its instantaneous distance, which varies with time.

If the latitude and longitude of the observation station are λ and ψ, the declination of the celestial body is δ and the time is H, then the angle θ is related to them as follows:

$$\cos\theta = \sin\varphi \sin\delta + \cos\varphi \cos\delta \cos(H-\lambda).$$

Substituting this into equation (8), we obtain

$$W_2 = G\left(\frac{c}{R}\right)^3\left(\frac{\rho}{a}\right)^2 \left\{3\left(\sin^2\varphi - \frac{1}{3}\right)\left(\sin^2\delta - \frac{1}{3}\right) + \right.$$
$$\left. + \sin 2\varphi \sin 2\delta \cos(H-\lambda) + \cos^2\varphi \cos^2\delta \cos 2(H-\lambda)\right\}. \qquad (10)$$

Here there are three terms. The first term includes only the latitude and declination. The former varies with the observing station. It is constant for a given station. The latter changes with the moon's or sun's declination. For the moon, the period is 14 days, and for the sun it is half a year. This is a zonal harmonic. If we expand further, we can obtain all the long-period tidal wave components.

The second term has not only the latitude and declination, but also a time angle cosine. This is a tesseral harmonic. It includes all diurnal tidal components.

The third term includes the cosine of twice the hour angle. Accordingly after expanding it we can obtain all semidiurnal tidal wave components. This term is a sectoral harmonic.

In general, δ, H and c/R in equation (10) are all related to the five astronomical constants listed below and to the lunar time τ (or solar time t):

- s, the mean longitude of the moon;
- h, the mean longitude of the sun;
- p, the mean longitude of the moon at perigee;
- N, the mean tropic longitude of the ascending lunar node;
- p', the mean tropic longitude of the perihelion;
- τ, the lunar time.

Moreover we know that the average lunar time τ, the average solar time t and the siderial time Θ are related as follows:

$$\Theta = t + h = \tau + s.$$

Accordingly we can very easily convert the average solar time to average lunar time.

The formula for every tidal component is the sine or cosine of a linear combination of these components of the following form:

$$\begin{matrix}\cos\\ \sin\end{matrix}\{a\tau + bs + ch + dp + eN' + fp'\}. \tag{11}$$

where the coefficient before each of these variables is an integer, except for a which can be equal to zero (secular), 1 (diurnal), 2 (semidiurnal), or 3 (1/3 day); the others can be either negative or positive. In order to avoid negative values, we add 5 to every coefficient. Moreover, because the direction of motion of the lunar node is retrograde, we can let N' =-N. For example,

$$\cos\{065, 455\} = \cos(s - p)$$

where a, c, e and f are all equal to zero.

Again,

$$\sin\{137, 455\} = \sin(\tau - 2s + 2h - p)$$

and so on.

The above symbols are called the Doodson arguments.

Table 1 shows several important tidal components.

Table 1.

潮波 1	幅角 2	相对振幅 3	每小时的角速度 4	来源 5
O_1	sin(145, 555)	0.377	13°.943	月球周日波 6
K_1	sin(165, 555)	0.530	15°.041	日、月周日波 7
P_1	sin(163, 555)	0.175	14°.959	太阳周日波 8
M_2	cos(255, 555)	0.908	28°.984	月球半日波 9
N_2	cos(245, 655)	0.174	28°.440	月球椭率半日波 10
S_2	cos(273, 555)	0.423	30°.000	太阳半日波 11
K_2	cos(275, 555)	0.115	30°.082	日、月半日波 12

Key:

1.	Tide wave	7.	Lunar-solar diurnal wave
2.	Argument	8.	Solar diurnal wave
3.	Relative amplitude	9.	Lunar semidiurnal wave
4.	Angular velocity, per hour	10.	Lunar elliptic semidiurnal wave
5.	Source	11.	Solar semidiurnal wave
6.	Lunar diurnal wave	12.	Lunar-solar semidiurnal wave

The relative amplitude refers to the coefficient calculated when expanding the equation. To find the actual amplitude, we multiply by the corresponding constant. For example, to calculate the tidal potential of the moon, we have to multiply by 26,206 cm/sec^2; to calculate the average tidal height, we multiply by 26,206/g, i.e. by 26.7 cm; while the equilibrium tide height produced by the sun is equal to 26.7 x 0.46051 = 12.3 cm. The above data must also be multiplied by the corresponding latitude in term in equation (10) to obtain the amplitude at the observation point. The gravitational change is the derivative of the tidal potential with respect to the earth's radius, so that the base number should be equal to -26206 x 2/a = -82.2 x 10^{-6} cm/sec^2 = -82.2 microgals. This number must be multiplied by the latitude term in equation (10). The surface tilt is equal to

$$-\frac{1}{ag}\frac{\partial W_2}{\partial\varphi}$$ in a north-south direction;

$$-\frac{1}{ag\cos\varphi}\frac{\partial W_2}{\partial\lambda}$$ in an east-west direction.

Substituting into formula (10), we obtain the following (Table 2):

Table 2.

分 量 1	纬 度 项 2			基 数 6
	长 周 期 3	周日项 4	半日项 5	
南 北 7	$3\sin 2\varphi$	$2\cos 2\varphi$	$-\sin 2\varphi$	−0.65 $G(t)$ msec
东 西 8	0	$-2\sin\varphi$	$-2\cos\varphi$	

Key:

1.	Component	5.	Semidiurnal
2.	Latitude term	6.	Base number
3.	Lone period	7.	North-south
4.	Diurnal	8.	East-west

Below (see Fig. 1) are curves of some relatively important tidal wave components at different latitudes. Fig. 1a is the gravity change. The figure includes 3 diurnal and 3 semidiurnal components, namely O_1, P_1, K_1, and M_2, N_2 and S_2. Figs. 1b and 1c show tilt as a function of latitude. The former is semidiurnal and the latter is diurnal. The solid lines are in the north-south direction and the broken lines in the east-west direction; all are in milliseconds.

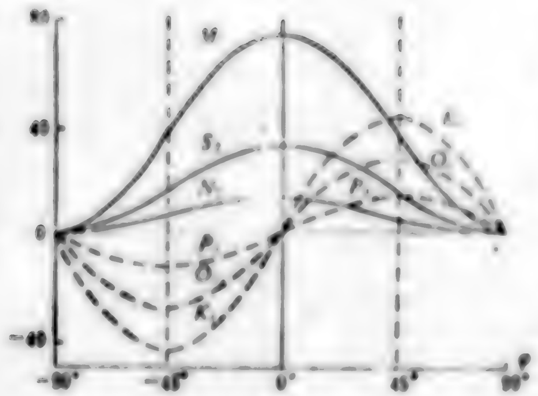

Fig. 1a.

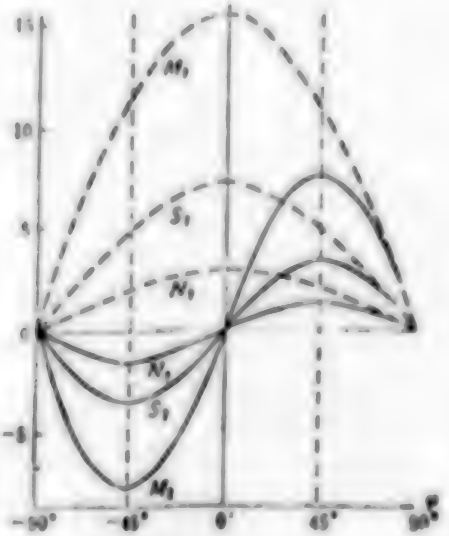

Fig. 1b.

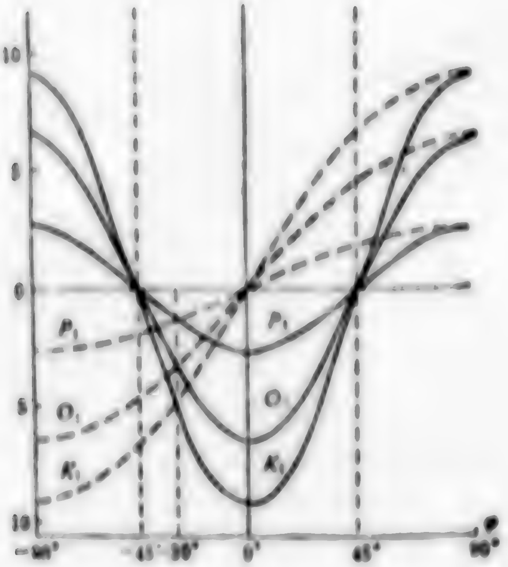

Fig. 1c.

5. Harmonic Analysis

The fixed time interval readings (e.g. every hour) of such factors as gravity change, tilt change and the like, obtained from observational instruments, and the joint instantaneous effects of solar and lunar tidal forces. They also include instrument error, indirect ocean effects and the effect of migration of material inside the earth and the like. These data cannot be compared with theoretical values. We must separate these observations into the tidal wave components of various frequencies discussed above in order to compare them. The separation technique must be harmonic analysis. Harmonic analysis of earth tides is an offshoot of ocean tide analysis. For earth tides, in deriving the theoretical values we must use extremely rigorous methods and the constants we use must be very precise. In the study of ocean tides this is of no importance, and in fact there is no entirely accurate data on the mass of the moon. Some wave components have very small amplitudes, but they are extremely important to the study of the elasticity and flow of the earth's interior. Accordingly, we not only need to calculate the theoretical values very precisely, we also must perform a very precise harmonic analysis of the observational data so as to be able to correctly separate these components; accordingly we must take account of the following problems.

1. We must use the most accurate astronomical and earth parameters known.

2. We must investigate the total duration and individual length of observations. For the six digits of the Doodson arguments, we can see that using one full day's observations we can separate different tidal wave components (first digit) such as secular, diurnal, semidiurnal. To separate components which differ by one unit in the second digit (e.g. M_2, N_2 and L_2), we need a month; for those which differ by two units we need half a month and so on. For the third digit, we need half a year or even a year's data to separate the terms.

For example, the wave components listed below are extremely important in investigating the effect of movements of the liquid core of the earth: π_1 (162,556), P_1 (163,555), S (164,554), K_1 (165,555), ψ_1 (166,554), and φ_1 (167,555). With a half year's data we can separate π_1, P_1, (S_1 + K_1 + ψ_1) and φ_1; but we need a full year's data to separate K_1 from S_1 and ψ_1. The value of S_1 is actually very small, but the effect of air temperature and air pressure changes on the instruments are based on the period of this component.

3. We must take account of instrument drift.

At the beginning of the first International Geophysical Year, electronic computers were not in very wide use, and the harmonic analysis of earth tides used the traditional ocean tide analytical methods. These were primarily the Duodson, Pertsev, and Lecolazet methods. The main characteristic of these methods was that they used simple filter coefficients to combine the observational data and to gradually separate the wave components of various periodicities.

In the middle 1960s, the above analytical methods were computerized one after the other, and computer calculations were made. But with modern computation technology, the preservation of past computation techniques, particularly the use of the simple filtering formula based on integers, is quite unnecessary, and moreover can scarcely satisfy the constantly growing precision requirements of earth tide analysis[13]. A. P. Venedikov of Bulgaria has created a new harmonic analysis method[18]. He used a computer to calculate 6 groups of non-integral filtering constants C_p and S_p (where p = 1, 2, 3). Every group has 48 coefficients which are multiplied by 48 readings taken over 2 days and then added together to separate the diurnal, semidiurnal and ter-diurnal components.

After combination of the 48 readings for each two-day period, we obtain six groups of data, two of which are the diurnal wave components (X_{1i}, Y_{1i}), two are the calculation of the semidiurnal components (X_{2i}, Y_{2i}), and in addition there are two for 1/3 day, in which the subscript i indicates sequence within each group.

The procedure given below allows direct computation of the ratio δ (gravity data) or γ (tilt data) and the phase lag g. We can set the precondition that the changes in δ and γ as well as the lag g are extremely small, and we can assume that they are proportional to the periodicity of the tidal component (or its frequency); with an analysis of many years' observational data, these conditions can largely be met. In particular, for tidal components whose frequencies are very close, the ratios and lag values are essentially constant.

6. The Ratios δ and γ

In the 1957 International Geophysical Year, the various countries of the world carried out large-scale earth tide observation work, and through harmonic analysis the ratios between the actual and theoretical values were found, giving δ and γ. Table 3 shows the value of γ obtained from tilt values for 433,864 hours' observation with clinometers at 14 stations and the δ values obtained from 252,288 hours' observation with gravimeters at 18 stations. Also presented are the Love numbers h and k derived from them and their ratio.

Table 3.

分波 [1]	[illegible] [2]	$\gamma = 1 + k - h$	$\delta = 1 + h - \frac{3}{2}k$	h	k	k/h
K_1	165.555	0.7420±0.0015	1.1455±0.0026	0.474	0.217	0.458
P_1	163.555	0.7059±0.0137	1.1530±0.0100	0.574	0.279	0.487
O_1	145.555	0.6788±0.0096	1.1628±0.0008	0.618	0.417	0.497
Q_1	135.655	0.6504±0.0207	1.1588±0.0095	0.741	0.482	0.522

Key:
1. Component
2. Doodson arguments

Here we have given some diurnal tide component data. The diurnal waves are rather strongly affected by movement of the liquid core of the earth. Investigation of these tide waves will be of assistance in elucidating the nature and movement of the earth's core. In 1966, Jeffreys and Vicente[4,6] pointed out that the Love numbers h, k and ℓ were related to the tide wave frequency ω as follows:

$$h(\omega_i) = h_0 + \omega_i h_1 + \cdots \qquad (12)$$

together with similar equations for k (ω_i) and $\ell(\omega_i)$. This is the so-called Jeffreys-Vicente conjecture. In 1972, Pekeris and Accad used a liquid-core earth model in calculations; they believed that the Adams-Williamson (1923) core density distribution condition

$$g_0 + \lambda\rho_0/\rho^2 = 0$$

is only one possible condition. The right side of this equation can be either positive or negative, i.e.

$$g_0 + \lambda\rho_0/\rho_0^2 = \beta(r)\cdot g_0. \qquad (13)$$

When β = 0, the density distribution is an equilibrium random distribution. The variation of the Love numbers with frequency is shown in Table 4[15]; (β = 0 or ± 0.2).

Table 4.

T (小时) hrs.	h			k			l		
	β = −0.2	β = 0	β = 0.2	β = −0.2	β = 0	β = 0.2	β = −0.2	β = 0	β = 0.2
6	0.6243	0.6253	0.6256	0.3068	0.3076	0.3084	0.0847	0.0847	0.0848
12	0.6162	0.6152	0.6154	0.3022	0.3028	0.3035	0.0840	0.0843	0.0843
24	0.6120	0.6127	0.6128	0.3009	0.3016	0.3023	0.0841	0.0842	0.0842
60	0.6118	0.6119	0.6119	0.3005	0.3012	0.3019	0.0840	0.0841	0.0842

Fig. 2 gives curves for the Love numbers for a stable liquid-core with $\beta = -0.2$ or 0 and $n = 2$, and shows the resonant effect when the period T is equal to 441,700,.... minutes.

Molodenskiy's theories are basically the same as the Jeffreys-Vicente ones. But their calculated results differ considerably[14].

Lecolazet used observational data obtained with an improved North American gravimeter and a Lacouste gravimeter in Strasbourg, France, and R. Brain's data from Frankfurt, W. Germany, in an analysis which determined the values of δ shown in Table 3[6]. The relationship of components K_1 and ψ_1 which are close to the resonance frequency line is clearly apparent.

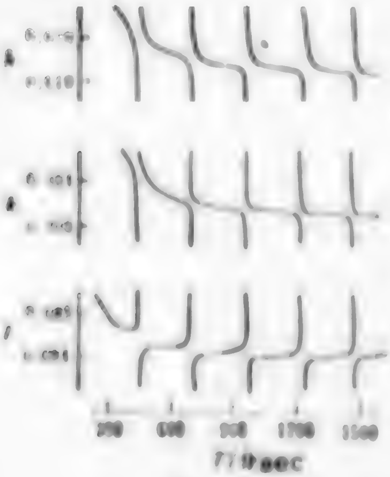

图 2

Fig. 2

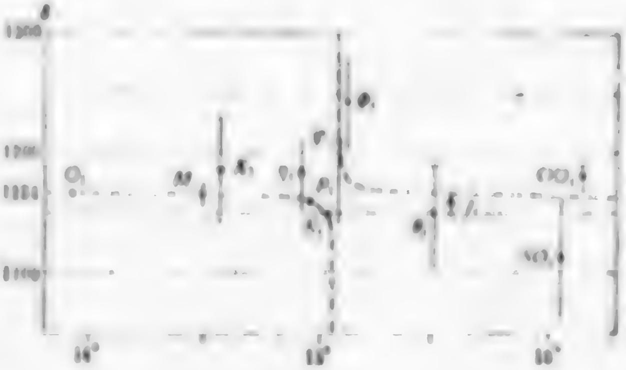

图 3

Fig. 3

7. Earth Waves and Astronomy

In the astronomical literature we frequently see the nutation formulas[16, 23]:

nutation in the obliquity

$$\Delta\varepsilon = 9''21\cos\Omega - 0''09\cos 2\Omega + 0''55\cos 2L - 0''09\cos 2L',$$

nutation in longitude

$$\left.\begin{aligned}\Delta\psi\sin\varepsilon = &-6''86\sin\Omega + 0''08 2\Omega - 0''51\sin 2L \\ &- 0''08\sin 2L' + 0''05\sin g - 0''03\sin g'.\end{aligned}\right\} \quad (13)$$

where Q is the longitude of the lunar ascending mode; L and L' are the longitudes of the sun and moon; g and g' are equal to (L-Γ) and L-Γ') respectively; and Γ and Γ^1 are the longitudes at perigee of the moon and sun respectively. If we convert them into the 5 astronomical coefficients given above, we obtain: Q = N, L = S, L' = h, and (L-Γ) and (L' - Γ') are equal to (s-p) and (h-p'). The constant 9.210" was determined by Newcomb. Later, at a 1977 astronomical conference, he proposed changing it to 9.206".

In 1968 Melchior derived formulas for nutation and tidal potential[12]

$$\left.\begin{aligned}\Delta\phi\sin\varepsilon &= -E\sum_i \frac{\omega}{\Delta\omega_i}(A_i + A_{-i})\sin(\Delta\omega_i t), \\ \Delta\varepsilon &= -E\sum_i \frac{\omega}{\Delta\omega_i}(A_i - A_{-i})\cos(\Delta\omega_i t).\end{aligned}\right\} \quad (14)$$

where E is the constant

$$E = \frac{3}{2}\frac{Gm}{R^3}\frac{C-A}{C}\frac{1}{\omega^2} = 0''0164,$$

ω is the angular speed of the earth's rotation (ω= 15.04106863 deg/hr); $\Delta\omega_1$ is the difference between ω and either angular velocity ω_1 or ω_{-1} of two components symmetrically located on both sides of K_1: $\Delta\omega_1 = \omega_1 - \omega = \omega - \omega_{-1}$; and A_1 and A_{-1} are the relative amplitudes of the two symmetrical components.

Melchior used these formulas to calculate an extremely exhaustive nutation table including 43 terms. He used two nutation constants,

N = 9.2100", for which E = 0.0164120";

N = 9.2272", for which E = 0.0164427";

If we take the derivative of equation (14) with respect to time t, we obtain the change in nutation as a function of time. It contains one term which, when $\Delta\omega_1 = 0$, is equal to a term of tidal wave component K_1, and gives the precession of the equinoxes, i.e.

All of the above activities are investigations of precession, and accordingly they have provided rich data for the elasticity of the earth's interior. But this problem is extremely complex.

Euler proved that if the two smaller angular momenta of the earth are the same, the axis of rotation will turn about the large and inertial axis, and the period will be C/(C-A) times the earth's period of rotation, where C and A are the large and the smaller rotational inertia values respectively. On the basis of precession of the equinoxes and nutation, this coefficient is equal to 305 days. Accordingly, the period of the wobble of the axis of rotation is 305 siderial days; this is what is called the "Euler free nutation period," and was derived by Euler on the assumption that the earth is a rigid body. This is not entirely applicable to the real earth, but before the beginning of work by the International Latitude Service, many astronomers took part in observational work to verify the 305-day period, without result. In 1891, Chandler discovered that precession included 2 periods, with lengths of 1 year and 14 months, and with an amplitude of about 0.1". Later, Newcomb pointed out that the reason that the Euler free nutation period was 14 months rather than 10 was the elasticity of the earth[2].

Thus the longer period, i.e. the Chandler period, should be related to the Love number k. If we assume that the ratio of the free nutation period to this period is τ_0/τ, then we have

$$k = \left(\frac{2\alpha}{m} - 1\right)\left(1 - \frac{\tau_0}{\tau}\right),$$

where α is the flattening of the earth and is equal to 1/298.3, and

$$m = \frac{\omega^2 a^3 (1 - \alpha)}{GM} = 1/288.$$

If we set k = 0.290, then τ should be equal to 440 days. But this also includes an ocean effect of 35 days. Accordingly, if the observed period is 440 days, then the period for an earth with no ocean effect should be 405 days, equivalent to k = 0.230. This differs rather widely from the results of actual observations.

According to the results of more than 70 years of observation, is somewhere between 414 and 440 days. Moreover, the precession amplitude varies from year to year and the path is also very uneven: this is the so-called "Chandler wobble." The reason for this wobble has not yet been elucidated.

Finally, the earth's rotational speed also varies. Over a long period, many scientists have discovered a continuous slowing of the earth's rotational speed. For example, from the growth rings of coral it is possible to calculate the number of days per year in different geological periods, from which we can infer the length of the day. Wells found that in the Devonian period (3.5 billion years ago) the year had 400 days; in the Triassic period (1.8 billion years ago), it had 380 days. Calculated from these data, every 100,000 years the earth's rotational speed slows by 2 seconds[19]. On the basis of ancient historical records of solar eclipses and solar eclipse calculations of the last 200 years, we can calculate results which are largely in agreement.

Recently astronomical observation techniques and instruments have made considerable progress, and in particular the appearance of atomic clocks has made this work much more profound. The change in the earth's rotational speed other than the secular slowing trend includes both periodic and irregular changes. The speed change within the year is $+22 \sin 2t - 12 \cos 2t$ milliseconds, and the maximum change is 44 milliseconds; the half-year speed change is $-6 \sin 4t + 7 \cos 4t$ milliseconds and the maximum value is 14 milliseconds. This is a relatively long-period change. In addition there are monthly and half-monthly changes and irregular ones.

The problem of the earth's rotational speed can be analyzed in terms of astronomical observation data or can be investigated in terms of earth tides. Because the earth has a certain elasticity, when the celestial bodies are close, the earth's surface rises, with an amplitude proportional to $\gamma = 1 + k - h$; the parts which rise always lag behind the tidal force. As a result, the attractive force of the moon produces a torque, causing a resistance to the earth's rotation. The size of the torque is related to the lag angle k, i.e. is proportional to sin 2k, and is also proportional to the Love number k[10]. According to observational results, the lag angle differs with location, being +0.7° (fast) in Western Europe and -1.7° (slow) in Eastern Europe, while in Central Asia it is -3.5°. But the actual lag angle ε is related to δ[10], i.e.

$$\tan 2\varepsilon = \frac{\delta \sin \varepsilon}{\delta \cos \varepsilon - 1}$$

Melchior assumed that k = 1°, so that $2\varepsilon \approx 7^\circ$. Calculating from this angle, we can obtain a result which is in accord with the paleontological estimates, i.e. every 100,000 years the length of the day increases by 2 seconds. This datum correspond to 20 percent of the current observed heat flux (if we assume that the total heat flux passes through the crust).

BIBLIOGRAPHY

1. Ducarme, B., and Melchior, P. "A Trans-World Gravity Profile," COMM. DE OBS. ROY. BELG., SER. GEOPHY., 132, 1978.

2. Jeffreys, H. "The Earth," 4th ed., Mcmillan, New York, 1950.

3. Jeffreys, H. MON. NOT., ROY. AST. SOC., 109-110, 150.

4. Jeffreys, H., and Vicente, R. O. MEM. ACAD. ROY. BELG., 37, 3-30, 1966.

5. Kuo, J. T. et al., "Transcontinental Gravity Profile Across the United States," SCIENCE, 1968, 968-971, 1970.

6. Lecolazet, R., and Melchior, P. "Experimental Determination of the Dynamical Effects of the Liquid Core of the Earth," ANN. DE GEOPHY., 33, 1, 11-22, 1977.

7. Love, A. "A Treatise of the Math. Theory of Elasticity," 4th ed., 1927, p 259.

8. Markowitz, Wm. "Rot. Acceleration, Rot. of the Earth," 1972.

9. Melchior, P. "Earth Tides," in "Adv. in Geoph.," 4, 1958.

10. Melchior, P. "Physique et Dynamique Planetaires [Planetary Physics and Dynamics]," Vol 4, p 28, Bruxelles, 1973.

11. Melchior, P. "Past and Future of Research Methods in the Problem of Earth Rotation," COMM. DE OBS. ROY. BLEG., SER. GEOPHY., 107, 1972.

12. Melchior, P. "Prec. and Not. and Tidal Problem," PUBL. DE L'INST. D'ASTRON. ET DE GEOPHYS. GEORGES LEMENTRE, Vol 5.

13. Melchior, P. "Harmonic Analysis of the Earth Tides," ibid., Vol VI.

14. Molodensiy, D. S. "The Theory of Nutations and Diurnal Earth Tides," COMM. OBS. ROY. BELG., SER. GEOPHYS., 58, 25-56, 1961.

15. Pekeris, C. L., and Accad, Y. "Dynamics of the Liquid Core of the Earth," PHIL. TRANS. ROY. SOC., SER. A, 273, 237-260, 1972.

16. Smart, W. M. "Celes. Mech.," 1953.

17. Takeuchi, H. "On the Earth Tide of the Compressible Earth of Variable Density and Elasticity," TRANS. AM. GEOPHYS. UN., 31, 5, 651-689, 1950.

18. Venedikov, A. P. "A Method of Analyzing Earth Tides on the Basis of Measurements of Arbitrary Length," COMM. OBS. ROY. BELG., SER. GEOPHYS., 71, 1966 [in French].

19. Molodenskiy, M. S. "Elastic Tides, Free Nutation and Some Problems of the Earth's Structure," TR. GEOFIZICH. INSTIT. [Transactions of the Geophysical Institute], No 19 (146), 3-52, 1953 [in Russian].

21. Pariskiy, N. N. "Earth Tides and the Internal Structure of the Earth," IZV. AKAD. NAUK. SSSR, SER. GEOFIZ. [Izvestiye of USSR Academy of Sciences, Geophysical Series]," No 2, 193-215, 1963 [in Russian].

22. Fang Jun [2455 0193], "Zhongli celiang yu diqiu xingzhuang [Gravimetric Surveying and the Figure of the Earth], Vol 2, p 163, 1975.

23. Blazhko, "A Course in Spherical Astronomy" [Chinese translation from Russian], pp 306-30

8480
CSO: 4008

LIFE SCIENCES

MARRIAGE BETWEEN CLOSE RELATIVES DISCOURAGED

Beijing BEIJING RIBAO in Chinese 12 Apr 80 p 2

[Article by Sun Nianlu [1327 1819 1833]: "Marriage Between Close Relatives Is Not Good"]

[Text] People of the older generation all know the saying "adding kinship to kinship." Many novels and dramas such as "Hongloumeng," "Zhenzhuta" also described many stories about love and marriage between cousins who have grown up together. This seems to be a kind of story of an exemplary deed. From the scientific viewpoint, this kind of marriage is not good. The number of hereditary diseases occuring among children of marriages between cousins is higher than that among children of marriages of unrelated persons. A survey conducted by the World Health Organization showed the death rate of babies of marriages between closely related relatives is three times higher than that of marriages of unrelated persons. Why is this so?

Human beings carry many kinds of hereditary diseases. Of these, several hundred are recessive hereditary diseases. In normal people, almost everyone carries five or six kinds of genes that cause such diseases, but the variety carried by each person is not the same as that of the other. People carrying such disease inducing genes are not affected because of the presence of normal dominant genes. But when two people carrying the genes of the same recessive hereditary disease are married, there is a one in four chance that these two recessive genes will come together in the offspring, will be affected by the disease.

Therefore in seeking a mate, it is best not to seek a person carrying the same disease inducing genes as oneself. Our nation's marriage laws prohibit marriages between persons directly related by blood, but marriages between close relatives are also not good. Marriage between close relatives mainly refers to marriage between cousins. His father and her mother are brother and sister directly related by blood. Half of the genes of the brother and of the sister directly related by blood comes from their father and the other half comes from their mother. Therefore the possibility that the genes of the brother and the sister may be the same is one half.

After the brother and the sister separately marry, their offspring are cousins. Half of the genes of the male cousin comes from his father. This means the possibility that his genes are the same as his father's is one half. The possibility that the genes of the female cousin are the same as her mother's is also one half, as is the possibility that the genes of his father and her mother are the same. Therefore, the possibility that the genes of the cousins are the same is 1/2 x 1/2 x 1/2 = 1/8. If in this family there are certain recessive genes of hereditary disease, the disease will easily occur after marriage. Therefore, in relatively closed-in villages in mountain regions, the percentages of cases of dementia, deafness, mute, phenylketonuria are all higher than those of normal groups of people. Therefore young people should start out from the point of view of genetics and eugenics and avoid marriages between close relatives to assure the healthy growth of the next generation.

9296
CSO: 4008

LIFE SCIENCES

CONFERENCE ON CLINICAL APPLICATIONS OF COMPUTER SOFTWARE HELD

Beijing GUANGMING RIBAO in Chinese 24 Apr 80 p 2

[Text] In order to expand the use of computers in medicine, during the last 10 days of March the First National Conference on Medical Applications of Computer Software was held in Nanking.

As modern science and technology have progressed, computers have come into wide use in the field of medicine. Computers are capable of taking over from medical attendants such toilsome work as management of medical records, automatic analysis and reporting of examination results, automated diagnosis, automatic monitoring of gravely ill patients, automatic adjustment of medicine dosages and the like.

At the conference, an exchange of experience on computer applications in medicine took place with reference to computers currently installed and in use by medical and public health departments in this country. The participants observed an on-the-spot demonstration of the DJS-131 multipurpose minicomputer system which has just been set up by the Nanking Command General Hospital, and heard a brief and highly stimulating introduction to the installation and utilization of the system. At the meeting, nine units, including the People's Liberation Army General Hospital, the Institute of Military Medicine, the Capital Hospital of the Institute of Traditional Chinese Medicine and the Shanghai No 1 Medical Institute presented 15 specialized talks which dealt with research results, applications of computers in liver cancer, gastric ulcer, supporting diagnosis of gall bladder, liver and pancreatic disease, vital signs analysis and drug dynamics analysis, as well as traditional Chinese medical treatment, and case management, all of which were well received by the conference participants.

At the meeting, this country's first cooperative network for computerized medical-use software was set up, with 38 units participating.

This conference was hosted by six units, including the Nanking Command General Hospital and the Shanghai Computer Plant, with the support of the General Office of the National Computer Industry and the Rear Services and Public Health Departments of the People's Liberation Army. A total of 180 representatives of army and local hospitals, universities, computer departments, research institutes and 99 Communist Party units, participated.

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CSO: 4008

SHANGHAI MUNICIPAL COMMUNICATIONS ENGINEERING SOCIETY FOUNDED

Shanghai JIEFANG RIBAO in Chinese 21 Dec 79 p 2

[JIEFANG RIBAO 21 December report: "New Engineering Society To Promote Modernization of Municipal Communications and Transportation, and the Adoption of a Scientific Style"]

[Text] The Shanghai Municipal Communications Engineering Society [0006 3189 1579 0074 6639 1562 4453 1331 2585] held its inaugural meeting on 15 December in the Hall of Sciences.

Communications and transportation have developed to some extent in Shanghai since liberation, but they are still far from being suited to the needs of production and the livelihood of the city's people. For many years the people of Shanghai have had a crying need for an amelioration of their city's traffic problems. Various communications and urban construction departments, as well as specialists and scholars in engineering circles, have put forward many sound proposals. Now that the communications engineering society has been established, it will organize scientific and technical workers and other necessary personnel in disciplines relevant to communications engineering and will have them actively carry out academic activities aimed at developing communications engineering technology, so that they may contribute to the achievement of the modernization of the city's communications and transportation.

Municipal Revolutionary Committee Deputy Director Di Jingxiang [3695 2529 5980], consultant Li Gancheng [2621 1626 2052], and Chinese People's Political Consultative Conference Municipal Vice Chairman Zhao Zukang [6392 4371 1660] were among those who attended the meeting and addressed the audience.

[illegible]
CSO: 4008

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

NOTED METEOROLOGIST YE DUZHENG ADMITTED TO THE PARTY

Beijing GUANGMING RIBAO in Chinese 9 Jan 80 p 1

[Text] Noted meteorologist Ye Duzheng [5509 4648 2973], delegate to the Fifth National People's Congress, director of the Chinese Meteorological Society, and a member of the Atmospheric Physics Institute of the Chinese Academy of Sciences, recently joined the Chinese Communist Party.

Comrade Ye Duzheng studied in America during his early years. After the new China was founded, he surmounted rigorous obstacles and resolutely returned home to participate in socialist construction. In pursuance of the development of meteorology in our country, he has made important contributions during the past 30 years, not only through his research on atmospheric circulation, weather dynamics, atmospheric physics, and applications of new technology, but also through his establishment of the study of climatic data and his work on numerical forecasting, and he has trained talented scientific research personnel.

After the "gang of four" was smashed, Ye Duzheng found himself possessed of even greater vigor and vitality, and he resolved to dedicate all of his strength to the cause of socialist modernization and construction.

9292
CSO: 4008

INITIAL NATIONAL COMPUTATIONAL MATHEMATICS MEETING HELD

Guangzhou NANFANG RIBAO in Chinese 23 Dec 79 p 1

[NANFANG RIBAO 23 December report: "The Study of Finite Elements in China Comes Up to Advanced World Standards"]

[Text] The Computational Mathematics Branch of the China Mathematics Society recently held its first annual meeting in Guangzhou. At the meeting Feng Kang [7458 1660], a research fellow at the Computer Technology Institute of the Chinese Academy of Sciences, presented an academic report entitled "Numerical Value Solutions of Finite Elements, Integral Equations, and Differential Equations." The results of the studies discussed in this report show that the study of finite elements in China comes up to advanced world standards.

Computational mathematics is a discipline closely related to our country's four modernizations. Finite element method is an advanced method used with electronic computers. It has great theoretical and practical significance. This method can be used to solve computation problems associated with large-scale, complex engineering projects and scientific experiments. The use of the finite element method in connection with such undertakings as engineering projects in the atomic energy field, analyses of the strength of aircraft, and calculations of the stress on dams can raise the quality of design and save great quantities of material.

The Chinese Academy of Sciences, a number of ministries and commissions subordinate to the Party Central Committee, relevant scientific research units from every province and all major cities, specialists from colleges and universities, and Professors Zhao Fangxiong [6392 6078 3574], Xu Xianyu [1776 3759 3842], and Zhou Yulin [0719 3022 7792]--more than 200 people in all--participated in this first annual meeting. They exchanged a total of 170 papers, and these treatises reflect striking increases in recent years in the quality and range of application of theoretical studies in computational mathematics in China.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

BRIEFS

GERONTOLOGY SOCIETY--The Shanghai Branch of the China Medical Society recently established the Shanghai Gerontology Society [Shanghai Laonian Yixuehui 0006 3189 5071 1628 6829 1331 2585]. Dong Chengland [5516 2110 3809], director of the Internal Medicine Department at the Shanghai Sixth Municipal Hospital; Wang Youqi [3769 2589 3825], a professor at the Physiology Teaching and Research Section, Shanghai First Medical College; Huang Wendong [7806 2429 2639], president of Shanghai College of Chinese Traditional Medicine; and Guang Ankun [6782 1344 1024], vice president of Shanghai Second Medical College, were named as advisers to this new society, while Xui Bangqi [5641 6721 4388], director of Huadong [East China] Hospital was named the chairman of the board of directors. [Text] [Hong Kong ZHONGGUO XINWEN in Chinese 17 Apr 80 p 7]

CSO: 4008

AUTHOR: None

ORG: Acheng Relay Plant

TITLE: "Hard Alloy Impact-cut Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 1-7

ABSTRACT: In 1966, the Acheng Relay Plant began to make 2 models of impact-cut molds, YG15 and GT20, with a hard alloy. To date, a total of 70 sets have been produced and most of them have been used in production. Practice has proved that hard alloy molds have a useful life 20-30 times that of steel molds, 60 times in some cases. For example, the magnetic part of the GL-10 overflow relay is made of D11 silicon steel of a thickness of 0.5mm. The set of molds have been in use since Apr 77, and to date 1,260,000 pieces have been produced; the estimated useful life of these molds should be above 40,000,000 times. The structure design of the molds, the major work process and the needed tools are described. Selection of more malleable hard alloys with impact resistance and the structure of complex impact cut molds are subjects being further improved at present.

AUTHOR: None

ORG: Shanghai Machine Tool Electricals Plant

TITLE: "E-Shaped Silicon Steel Plate Hard Alloy Impact Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 7-10

ABSTRACT: The production of silicon steel plates at the plant had been increasing yearly and in 1964 the plant began to adopt hard alloy impact mold to make them. Since then, the useful life of the blade has reached 600,000 to 1,200,000 plates, but remains unstable. Factors affecting the useful life of the molds have not yet been seriously tested and analysed, however. According to related literatures, these factors include mainly abrasion, fatigue, and adhesion. Beside long useful life, the hard alloy molds also have other desirable properties, of course. On the basis of several different alloy materials and variations of mold structure, a preliminary study for the purpose of improving these molds is reported.

AUTHOR: ZHANG Zhengxiu [1728 2973 [illegible]]

ORG: Designing Office, Xi'an Instrument Plant, First Ministry of Machines

TITLE: "Precision Impact Mold Designing"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 11-28

ABSTRACT: The designing process of precision impact molds is discussed in the paper in 3 parts: (1) Major factors of designing, including the determination of the cutting gap, arrangement of the parts to be formed, the lubricating system of the mold, computation of pressure, and selection of equipment, etc. (2) Calculation of work load and other properties. (3) Various types of precision impact mold and their structures. Drawings are included to compare the structures of various complex molds.

AUTHOR: None

ORG: Wuxi Mold Tools Plant

TITLE: "Designing and Manufacture of Precision Impact Mold Frame"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 29-31

ABSTRACT: Due to the special compression theory of the molding process and the requirement of a small gap between the positive and the negative molds, the ordinary press is not useable with precision impact molds. With the help of the Office of Machines and Electricals of the First Ministry of Machines, the authors designed and made a hydraulic frame to be used with 100 ton press and another for above 300 ton presses. The structures of the 2 frames are the same. When a hydraulic pressure system is installed, the frames may be adjusted to perform 3 compression motions. These frames provide the best condition for popularization of precision forming technique in China.

AUTHOR: None

ORG: Tool Designing Group, Shanghai Xianfeng Electrical Plant

TITLE: "Three-in-One and Three-not-Smooth Complex Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 32-35

ABSTRACT: For dynamos, the stator and rotor require a high degree of concentricity, the grooves must be identical, and the groove space must be even, etc.; therefore, molds must be specially designed to produce them. The structures of these molds are further determined by the quantity of each batch of iron cores to be produced. According to reference literature, the United States was the first to adopt the method of adding air-gap ring to the step-advance mold to complete the entire process of forming the rotor iron core. In view of this high speed impact-out process, whatever shape of complex mold used with ordinary press will not bring the Chinese manufacture process to the advanced stage. In 1972, the group successfully made 2 types of complex molds for the purpose of forming intermediate and small dynamo iron cores. They are offered in the paper as possible transitional structures until the supply of silicon steel roll materials and other conditions become more favorable.

AUTHOR: LIU Shushan [0491 2885 1472]

ORG: Tool Designing Group, Changchun Municipal Dynamo Plant

TITLE: "Improving Input Mechanism of the Complex Mold for Small Dynamo Stator"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 35-36

ABSTRACT: The major product of Changchun Municipal Dynamo Plant is small and medium size A.C. generators, with JO_2*6-9 small dynamos in the largest quantity. The original design of the complex mold for forming the stator was satisfactory so far as the product quality was concerned, but the input and output boards, the transmission rod, and the cover have to be constantly replaced due to deformation. The regular repairs were costly and time consuming. The author and colleagues made some improvements to the structure of the mold and formulated a procedure of adjusting the input board as the blade of the mold is wearing out. These improvements successfully overcame the original problems. The original structure of the mold and the improved structure are explained with drawings depicting the changes.

AUTHOR: None

ORG: Mold Machine Shop, Changsheng Electricals First Plant, Zunyi

TITLE: "Punch Pressing Hollow Parts"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 37-43

ABSTRACT: The Changsheng Electricals First Plant succeeded in trying to make the DYT11 high voltage pressure regulating switch. It is an advanced design with relatively complex structure. Most of the parts require very little milling. This is an advanced product of the 70's. The punch pressed parts of this product include several hollow parts of high precision requirements. They formed the major problem in the designing process. Following studying reference literatures and consulting Shanghai Switch Plant, the Mold Specialty of Shanghai Municipal Science Association, the 530 Teaching and Research Group of Shanghai Jiatong University, and others, the plant finally succeeded in making these hollow parts. The work procedures and the structures of these hollow parts are described.

AUTHOR: FENG Chunlan [7458 2504 5695]
CHENG Yixin [2110 0308 2425]

ORG: FENG of Shanghai Instrument Steel Mold Plant; CHENG of Shanghai Electrical Instrument Plant

TITLE: "Designing of Cylindrical Positive and Reverse Pulling Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 43-47

ABSTRACT: A set of complex mold is adopted for the design to accomplish materials input and positive and reverse drawing in one operation. Although the structure of the mold is rather complicated, the labor productivity is twice as high as the multi-step process with simpler molds. The reduction of one intermediate annealing procedure reduces the cost of production. If pneumatic device is added to the mold, the product may be moved within the work region to make the realization of automation easy. The authors used the mold to draw copper plate and steel plate, the parts produced proved satisfactory in both cases.

AUTHOR: WANG Shijun [3769 4311 0689]

ORG: Tool Department, Second Automobile Plant

TITLE: "Adjustment of Cable Bar Continuous Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS OF MOLDS] in Chinese No 1, 15 Mar 79 pp 48-50

ABSTRACT: The Second Automobile Plant uses the continuous mold structure to form such parts as the cable bar. The process of cutting notches, punching holes, bending, etc. is arranged in one operation. The punch mold is composed of 6 units to form 2 rows for continuous production. The material is fed manually and 2 parts are punched out with each feeding. During the testing process, the 2 parts are often not separated at the place of the semi-circular hole, the mold must be carefully re-aligned before the next punch, and when the alighment is not precise 6 parts are waste out of every 1m length of material. Adjustment to the mold to overcome these problems is explained.

AUTHOR: None

ORG: Guangzhou Automobile Manufacturing Plant

TITLE: "Simple Drawing Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 51-53

ABSTRACT: Among the cold punched parts of the automobile body, the fender requires the most pulling. At present, the Guangzhou Automobile Manufacturing Plant does not have a dual motion press. It depends entirely upon the mold structure to form the deeply drawn form. Such is also the case with the rear bumper, which has a very large curve. In 2 separate parts, this paper describes the molds used at the plant to form these parts satisfactorily without requiring other special machine tools.

AUTHOR: CHEN Denghou [7115 4098 [illegible]]

ORG: Shanghai Navigation Instrument Plant

TITLE: "Polyaminoester Thin Plate Impact Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 53-56

ABSTRACT: In meter manufacturing, there are often punched parts of a thickness of 0.0-0.3mm. The material is often thin and soft while the finished parts do not permit rough spots. The Shanghai Navigation Instrument Plant had been using steel mold to make these parts. The useful life of the mold was very short while the products were less than satisfactory. Early in 1975, the author and colleagues experimented with and made a set of polyaminoester rubber concave mold. The cost is only 1/3 of that of the steel mold. The gap between the concave and convex molds is self adjusting to produce parts of various designated thickness. The structure and the major properties of the polyaminoester mold are given.

AUTHOR: ZHANG Huacheng [1728 5478 [illegible]]

ORG: Shanghai Powder Metallurgy Plant

TITLE: "Powder Metallurgy Material Cogwheel Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 57-59

ABSTRACT: Powder metallurgy is a new work process requiring little or no milling. The technique can be used to make many special materials, such as foam material, hard alloys, vaccum material, thermal resistant material, etc. which cannot be made with ordinary techniques. Many machine parts can thus be made directly without forging, milling, etc. The technique of powder metallurgy is inseparable from molds, and parts of complicated shapes often cannot be made with this technique due to difficulty of making precise molds. Following repeated experimentation, the author and colleagues successfully designed a work process of producing slanted cogwheels with an automatic hydraulic press. The structure of the mold and the procedure of working the negative mold to insure the precision of the cogs are briefly described.

AUTHOR: None

ORG: Shanghai Switch Plant

TITLE: "Experiment of Round Hole Punch Material Separation Property"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 59-61

ABSTRACT: In the past, foreign literatures were often used as the basis for calculating the capacity of the punch mold to be separated from the formed product. In these literatures, factors of pressure and boundary are taken into consideration but not the size of the gap. In actual production, the authors discovered that aside from the punch pressure and the size of the edge, the ability of the positive mold to eject the finished product is also related to the gap, the lubrication condition, etc. This paper reports an experiment with 1,2,3mm thick steel plates, 6 different gaps, and 7 different widths of boundary to produce data of 450 punched products. The equation and a graph for plotting the product ejecting ability coefficient curve are included. The structure of the punch mold used in the experiment is described .

AUTHOR: None

ORG: Shanghai Electrical Meter Plant

TITLE: "Analysis of the Quality of the Impact Cut Profile"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 62-66

ABSTRACT: In the process of impact cut, there are the 4 stages of elastic deformation, plastic deformation, crack occurrence and development, and breaking and separation. The cross section cut surface is composed of the 4 parts of round corners, smooth cut, rough cut, and bristly. In order to clarify the quality factors of the cut surface, the condition of the force received by the cut surface in the punch cut process is analysed. The results of the analysis are reported.

AUTHOR: None

ORG: Shanghai Switch Plant

TITLE: "Experiment Values of Geometric Measurement of Screw Thread Following Turning Technique to Thin Out the Edge"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 p 67

ABSTRACT: In the screw hole of punched parts, the technique of turning the edge to thin the thread is commonly adopted to increase the length of contact of the screw so as to increase the tightening property of the produced part, while reducing the weight of the part. At present, data concerning the geometric measurement of the treated hole are rare, while information on the subject in related literatures does not always agree. As a result, the designing of products and the designing of the mold are often not uniform. For the purpose of overcoming such an unreasonable phenomenon, an experiment was carried out in 1974 to acquire factual data. Results of the experiment are reported.

AUTHOR: None

ORG: Department of Production Procedure, Xiangtan Dynamo Plant

TITLE: "Adopting Large Gap for Impact Cut of Black Metal Materials"

SOURCE: Guilin MOJU TONGZUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 p 68

ABSTRACT: The size of the gap in the punch cut procedure directly affects the precision of the product, the quality of the cut surface, the size of the punch force, and the wear property of the mold. Before 1964, the gap had been determined according to related data published by the Soviet Union. Practice since then has proved that these data are basically satisfactory with respect to colored metals. When these values are used to punch cut black metals, the gap is found to be too small, however. The concave and convex parts of the mold appear to be not completely aligned to cause a second cutting to be necessary so as to affect the quality of the cut surface. For this and other problems, the gap has been redetermined for processing parts made of black metals. The revised values are listed in a table.

AUTHOR: None

ORG: Department of Production Procedures, Xiangtan Dynamo Plant

TITLE: "Press Extension of Curved Rotating Body"

SOURCE: Guilin MOJU TONGZUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 69-70

ABSTRACT: The process of punch extension to produce curved rotating body is very different from using the same process to produce cylindrical bodies. The gradient increases as the curve line rises so that the material of the concave part of the mold becomes less stable and wrinkles may easily occur. This paper reports a study of the work procedure for the primary purpose of preventing the occurrence of wrinkles in this work procedure.

AUTHOR: LI Shiben [2621 4311 2609]
YANG Yuying [2799 3768 5391]

ORG: Both of Harbin University of Engineering

TITLE: "Analysis of Repeated Pulling Deformation of High Box Shaped Articles and Calculation of the Work Procedure"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 70-76

ABSTRACT: When the relative height, H/r, of the high box shaped article exceeds the maximum height for one pulling operation and the product must be pulled several times to accomplish the desired depth, the deformation characteristics are not the same as thoseof a cylindrical product being repeatedly pulled, neither are they the same as those of a box shaped product being pulled only once. The key problem is the transitional shape and size of the intermediate steps. This paper explains the principle and method for calculating these values. Several other related problems are also extensively discussed.

AUTHOR: None

ORG: Shanghai Xinghuo Mold Tool Plant

TITLE: "Forming Brass Decoration By Punch Press and the Work Procedure"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 76-80

ABSTRACT: The brass ornaments are designed to decorate the windows of Chairman MAO's memorial. After the Shanghai Xinghuo Mold Tool Plant received the assignment, the party branch immediately organized a team to design and produce them and they were completed in 22 days, after struggling day and night to take care of this responsibility. The process of designing, forming, and producing these ornamentsthrough punch press are briefly reported in the paper. There are photos and drawings describing these ornaments.

AUTHOR: WU Shidun [0702 6108 1908]

ORG: Northwest Industrial University

TITLE: "Ways for Cold Press Molds to Lose Effectiveness and Measures to Prolong the Useful Life of Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 81-92

ABSTRACT: There are mainly 4 ways with which cold press molds may lose their effectiveness, including abrasive wear, plastic deformation, fatigue, and breakage. Following a discussion of these 4 ways, the paper proceeds to explain, in separate sections, damages to the convex mold and the causes, and damages to the concave mold and their causes. The paper concludes with a section explaining some effective measures for improving the useful life of molds.

AUTHOR: None

ORG: Kaifeng Tractor, Dynamo, and Electrical Instrument Plant; Zhengzhou Institute of Machinery

TITLE: "Cold Press of Starter Gears"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 93-106

ABSTRACT: The cold press procedure has been adopted to produce QD02A-521 starter gear to replace the original production procedure of inserting cogs and [illegible] finishing them. This cold press technique was first experimented by Zhengzhou Institute of Machinery in Aug 74 on a 160 ton general purpose oil press, and good products were immediately obtained. In 1975, Kaifeng Tractor Dynamo Electrical Instrument Plantbegan its experiment, including checking the useful life of the molds and calculating the technical and economic indices, and also began to produce gears in batches with this technique. Following another period of production testing, the technique formally replaced the original method in 1977. This paper reports the analysis of the new work procedure, the technical requirements, the mold design, the procedure of making the concave mold with the shape of the cogs, the reasonable use of the molds, the process of inspecting the precision of the cogs and the force of pressure, and research subjects to be studied in the future.

AUTHOR: YUAN Sirong [5913 2448 2837]
YAN Youhan [0917 3945 3352]

ORG: Both of Ganzhou Connecter and Inserter Plant

TITLE: "Investigation Into the Realisation of High Speed Production in Pressure Forming of Phenolic Plastics"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 107-111

ABSTRACT: In China, some advanced enterprises have adopted the pressure technique to form thermal solidifying plastics, but at present there remain many medium and small factories, the pressing and casting techniques are still being used. With the latter techniques, the molds are heavy, with many manual steps. The work is slow, the rate of waste products is high, and the power and labor consumption is very great. The possibilities of realising mold separation inside the machine for automated production are discussed. The paper includes drawings to depict ways of reconstructing existing oil presses to improve the production procedure of these plastics.

AUTHOR: None

ORG: Science and Technology Office, Shanghai Instrument and Telecommunication Industry Bureau

TITLE: "Opinions Concerning Reconstructing the Mold Specialty of the Bureau"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 1, 15 Mar 79 pp 112-113

ABSTRACT: At present, it takes a long time for very common molds to be produced. The processes of designing, preparing the materials, and making the molds take up a whole month each, while plastic molds and casting molds take more than half a year to make. This condition has affected the renewal of molds and the ability of China to compete on the world market with products of foreign countries. The cost of making molds is high and their useful life is short. In order to change this backward condition, the bureau proposes, in the paper, concrete steps of reconstructing the industry. This paper is prefaced by a note from the editor commenting on the importance of molds in industrial production and the hope that this paper will promote discussions on the subject.

6168
CSO: 4009

AUTHOR: None

ORG: Department of Science and Technology, Hefei Feihe Automobile Plant; Forge Press Teaching and Research Office, Hefei Industrial University

TITLE: "Forming Mold for a Large Cover of Iron and Wood Structure"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 1-2

ABSTRACT: Hefei Feihe Automobile Plant has been producing an 8 ton truck, the HF150 Jianghuai Model, since 1970. The size of the driver's cab roof is very large. It had been produced by welding 9 pieces of boards. The work was hard and the productivity was low. It did not look very nice either. In 1976, a mold was designed to manufacture the cover by pressure forming. In the designing process, related experience of Yunnan Automobile Plant and Hefei Jianghuai Automobile Plant was learned. In view of the 2 sets of molds already put in operation, the quality of the products is good. The structure of the cab cover and the mold are explained.

AUTHOR: None

ORG: Punch Press Group, Fifth Machine Shop, Changchun Optical Machinery Institute

TITLE: "Precision Graduation Punch Press of Multi-grooved Plates"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 2-4

ABSTRACT: The group has taken on assignments of several types of precision graduation punch press parts, including the punch plates of stators and rotors, with relatively high requirements of equi-graduation of the grooves. The group have made improvements to the graduation device of their punch press mold tools many times to cause the graduation precision of their products to be increasingly better. At present, the accumulated error of graduation of the products has been reduced to 20 sec, more than 10 times better than when the group took the first such assignment. This paper reports their experience in this continuous process of improvement.

AUTHOR: None

ORG: Department of Mechanics, Xi'an Electrical Rectifier Plant

TITLE: "A Study on Rubber Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 4-5

ABSTRACT: Using rubber to make mold tool is not a new creation, but the ordinary rubber is seldom used because of its poor viscosity. It was not until the so-called "fluid steel" polyaminoester rubber became available did it gain practical value as a mold material. In electrical industries, certain parts made of colored metals are often very thin; the alloy core plate of silicon tubes produced by the Xi'an Electrical Rectifier Plant is one of those. The mold tool for these parts must have very small gap and is very difficult to adjust. When rubber mold is used to replace the metal concave mold, the most difficult factor of controlling the gap is eliminated. The structure and work theory of the mold tool and the economic effects are reported. The design parameters are discussed.

AUTHOR: TANG Mingli [0781 2494 0536]

ORG: Xi'an Meter and Instrument Plant

TITLE: "New Type of Small Hole Punch Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 6-7

ABSTRACT: Comparing with drilling, the punch press technique for producing small holes is much more economically effective. The so-called small holes refer to the ratio between the diameter of the hole, D and the thickness of the punch article t. If $D/t \leqslant 1$, it is a small hole, and the smaller is the ratio the smaller is the hole. At present, the technique is to use a protective cover in the mold tool to produce small holes. Such molds are difficult to make and the economic efficiency is poor. This paper describes a set of new small hole punch mold. A drawing of the mold depicting its structure, the general condition of its performance, and its major characteristics are introduced.

AUTHOR: WANG Cheng [3769 2973]

ORG: Shenyang Low Voltage Switch Plant

TITLE: "Design of Complex Mold Structure"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 8-12

ABSTRACT: A Complex mold is a tool with which many work processes are performed. With it, for example, punch out, hole punch, edge cutting, embossing, forming, depth pulling, breaking, and bending may be accomplished at once. This paper discusses the conditions under which a complex mold should be the choice and should be economically feasible. The major portion of the paper is devoted to introducing several sets of typical complex mold structures which have produced good effects in production practice. Drawings are provided to depict all the molds under consideration.

AUTHOR: YANG Changshun [2799 7022 7311]

ORG: Jilin Jiangbei Machinery Plant

TITLE: "Hard Alloy Cold Press Mold Tool"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS OF MOLDS] in Chinese No 2, 15 Jun 79 pp 13-20

ABSTRACT: The possibility of cold pressing of steel parts is first determined by the condition of the tools. In the process of pressing and squeezing, the mold tool receives a large load of the metal, and in the process of metal flow, it also receives extremely large action of friction and temperature changes. When the unit force is greater than $200kg/mm^2$, the concave mold made of the alloy tool steel Cr12MO will suffer an obvious reduction of useful life so that the work procedure is difficult to accomplish under large quantity production conditions. If hard alloy is used to replace the ordinary chrome tool steel to make the concave mold, the mold cavity useful life may be greatly lengthened. This paper explains the properties of hard alloys, the basic theory of their use in mold design, the designing and assembly of hard alloy composite molds, and calculations and analysis of the designing process.

AUTHOR: LIU Wenbao [0491 2429 0202]

ORG: State-Operated Xinxing Instrument Plant

TITLE: "Application of Polyaminoester Rubber in Simple Precision Punch Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 22-23, 5

ABSTRACT: This paper introduces the experience of the plant in incorporating polyaminoester rubber and No 45 steel for making the mold tool for its cog-wheel products. Small batch productions have proved the superiority of the new mold in being long lasting and forming high quality products. The work properties of polyaminoester rubber and special characteristics of the mold tool made partially with this rubber are discussed.

AUTHOR: QIU Yongcheng [6726 3057 2052]

ORG: Beijing Mold Tool Plant

TITLE: "Transformer Framework Step-advance Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 24-25

ABSTRACT: There are transformers of many specifications but everyone of them has a framework which is made mostly of sheet plastic in a punch process. In the past, many factories made the framework with 2 sets of molds and 2 punch presses. The resultant parts often did not fit together very well, either too loose or too tight. This paper reports a new mold design, which produces the framework in one two-step advance operation. Drawings depicting various components of the mold tool are included.

AUTHOR: WANG Zhenan [3769 7201 1344]

ORG: Shanghai Sound Recorder Plant

TITLE: "Sound Recorder Magnetic Pickup Iron Core Plate Mold Tool"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 26-28

ABSTRACT: In the production process of sound recorders, the magnetic pickup is relatively difficult and complex to make, while the quality of the recorder is determined to a large degree by that of the magnetic pickup. The Shanghai Sound Recorder Plant has been making sound recorders for more than 20 years, but to this day, problems concerning making the iron core plate mold are still not completely resolved. The designing and manufacturing procedures of the iron core plate mold tool are described, alongside the outstanding problems.

AUTHOR: ZHANG Shengxiu [1728 2973 0208]

ORG: Design Division, Xi'an Meter and Instrument Factory

TITLE: "Structure of the Horizontal Motion of the Cold Punch Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 28-34

ABSTRACT: In the process of punch press of sheet material, horizontal motion is required simultaneously under many conditions to proceed with horizontal or even block movement even in the direction opposite to that of punch press to complete the work. In majority of the cases, certain accessory devices may be added to a single mold tool to accomplish the auxiliary horizontal movement, but the productivity will drop obviously to make the technique uneconomical. Cold punch mold with horizontal motion structure can proceed with continuous punch pressing and many deforming processes by complex punch press on a single set of mold tool. This type of mold structure is analyzed and designing and computation procedures are introduced.

AUTHOR: GUO Fuyuan [6751 4395 3293]

ORG: Mianyang P.O. Box 204, Sichuan

TITLE: "Spring Pressure Type Small Convex Mold Cover"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 35-36

ABSTRACT: Small holes with a diameter of 1mm are commonly required in the cold punch article while the material is 0.2-0.8mm in thickness due to product requirements. These holes give considerable trouble in the mold designing and the operation process. The convex mold has a small diameter and great elasticity and vibration and other factors often cause it to break or bend suddenly. The author and coleagues have experimented with many reforms to overcome these problems but the results have never been completely satisfactory. At present, a type of spring pressure small convex mold cover is being tested with preliminarily good results. The structure of this cover is introduced.

AUTHOR: LI Xuntang [2621 8113 1016]

ORG: Yiyang City Radio Materials Plant

TITLE: "Arrangement of Convex Mold of Punch Mold With Set Distance Side Blade Leap Step"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 16 Jun 79 pp 36-37

ABSTRACT: The punch mold with set distance side blade leap step can accurately and reliabliy control the material supply step distance and has high production efficiency. It makes it easy to realize punch press automation as well; therefore, it is often adopted for making medium and small sized thin products. After the most reasonable arrangement of materials has been determined, the convex mold and its fixing bed assembly, the strength of the concave mold, and the weight of the mold tool should be considered. The major portion of the paper discusses ways of arranging mold tools for punching more than one article in a single operation.

AUTHOR: WANG Zhilin [3769 5347 2651]

ORG: Shanghai Zhongya Radio Components Plant

TITLE: "Multi-processes Complex Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 p 38

ABSTRACT: The condenser produced by the Zhongya Radio Components Plant requires a precise case cover. The author and coleagues designed a complex mold to complete the 4 work processes of extension, punching 2 holes, turning raised edges, and cutting. Production of covers of various specifications has been carried out with the complex mold. The complex mold has successfully reduced the number of machines and workers and at the same time has guaranteed the product quality and production safety. The structure of the complex mold and its operating procedure are given.

AUTHOR: GUO Fuyuan [6751 4395 3293]

ORG: Mianyang P.O. Box 204

TITLE: "Extending-Contracting Style Guiding Head Design"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp39, 34

ABSTRACT: The guiding head of the mold described in the paper does not in fact extend or contract. The convex mold fixing assembly is in a floating state, however. Through spring motion, in the punch cut process, the convex mold rises and falls to accomplish the extension and contraction motions of the guiding head in the convex mold. The theory of this movement and the design of the mold tool are explained.

AUTHOR: NI Jianhua [0242 1696 5478]

ORG: Wu County Luoting Galvanized Iron Plant, Jiangsu Province

TITLE: "Simple and Precise Bar Material Shear-cut Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 40, 25

ABSTRACT: Based upon the theory of deformation occurrence when a bar-shaped material is sheared and cut, this paper introduces an open style precise shear and cut mold tool for bars or sticks. The mold tool is simple and highly efficient. The theory of shear-cut deformation and the structure of the mold are explained.

AUTHOR: ZHOU Qingcheng [0719 1987 2052]

ORG: Hangzhou Radio Sixth Plant

TITLE: "Tightening and Edge Cutting Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 p 41

ABSTRACT: The casing for the thick film circuit produced by the Hangzhou Radio Sixth Plant is formed by cold press of L_4 soft aluminum. Due to the metal flow deformation produced by the squeezing and pressing action, the edges are not even. They must be cut before the product meets the requred size. A set of mold is therefore designed to tighten the product and cut the edges. The design, the structure, and the performance of the mold tool are explained.

AUTHOR: WANG Shijun [3769 4311 0689]

ORG: Department of Tools, Second Automobile Body Plant

TITLE: "Improvement for The Screw of the Material Drop Board"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun p 42

ABSTRACT: The screw of the material drop board in a punch mold is to tightly fix the material drop board. Due to the fact that structurally, it is a fastener, it often becomes loose after a long period of vibration under excessive pressure. Sometimes, accidents may even occur when the screw comes off, and the mold, the equipment, or the worker may suffer damage. This paper describes a method of improving the screw structure to prevent it from being shaken loose. The measure was originally introduced in a Japanese literature.

AUTHOR: LIU Shushan [0491 2885 1472]

ORG: Department of Work Procedures, Changchun City Dynamo Plant

TITLE: "Central Guide Pin of Small Dynamo Stator-rotor Plate Divider"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 p 43

ABSTRACT: The small dynamo JO_2 3-6 stator-rotor plate punch press procedure is divided into 3 steps. The roll or sheet material is first cut into strips. Holes are then punched in the strips in 2 steps. In the third step, the axle hole is used to fix the position to separate the stator and rotor plates. With 2 separate drawings, this paper explains the faulty central guide pin of the original design which is difficult to operate and produces a large amount of waste products, and the improved design which has obviously eliminated many problems.

AUTHOR: TIAN Mengshi [3944 1125 1395]

ORG: Electrical Car Repair and Assembly Plant, Wushun Bureau of Mines

TITLE: "Wire Fitting No Waste Continous Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 44,43

ABSTRACT: Wire fittings are small parts of which a large quantity is needed in the Electrical Car Repair and Assembly Plant for its electrical products. In the past each fitting was punched individually. The material utilization rate was low and the production efficiency was poor also. Considerable improvement has been adopted in the design structure of the mold tool to produce a set of no waste continous mold tool. In the past few years, at the plant all wire fittings of various specifications have been made with this type of mold. The work theory is introduced.

AUTHOR: ZHU Yongde [2612 3057 1795]

ORG: Ningbo Eighth Middle School 857 Factory

TITLE: "Simple Device for Adjusting Mold, Pressing Edge, and Pushing out the Product--The Push-Press Accessory"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 p 45

ABSTRACT: A pieces of accessory device is designed and attached to the punch mold to adjust the mold, press the edges, and retrieve the product. After the installation of the device, the trouble of having the product lodged into the rubber cushion is eliminated and the surface of the product does not curve as much. The structure of the device is described.

AUTHOR: ZHANG Kuiwu [1728 7608 2976]

ORG: Shenkonghou Mechanical and Electrical Switch Plant, Benqi [Liaoning]

TITLE: "Introducing a Type of Mold Handle"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 p 46

ABSTRACT: Molds used for punch press tooling have handles of many different structures. This paper introduces a type of mold handle that is simple in structure and easy to make. It does not consume much material either. The structure of the mold handle for the currently common 16T punch machine is explained and illustrated.

AUTHOR: ZANG Shufan [5258 2611 5400]

ORG: Harbin Songjiang Tractor Plant

TITLE: "Application of Zinc Alloy in Punch-cut Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 47-49, 45

ABSTRACT: To pull, bend, form, and punch-cut mold tool with the injection technique under a temperature of about 450°C is a simple and easy technique for making mold tools. It has been used in Japan, the United States, and Germany. In China, this technique of making molds suitable for medium and small batch production has not yet received much attention. In Dec 77 the author and colleagues made a no gap punch mold with zinc alloy. Experimental use and testing proved the technique to be satisfactory. In Oct 78, they used the same alloy to make a punch-cut mold for manufacturing 08F steel plate parts of 1mm thickness. Production tests in 3300 parts production proved the mold to be ideal. This paper reports the experience and discusses related problems.

AUTHOR: LIANG Yanlong [2733 1750 7893]

ORG: Guizhou Gasoline Machinery Plant

TITLE: "Calculation of the Profile Area of the Inner Pouring Opening in Pressure Cast Mold Design"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 50-58

ABSTRACT: In the pressure cast process, some major work parameters, such as the filling time, the filling speed, the profile area of the inner pouring opening and its thickness are determined by experience here and abroad, in the majority of the cases. This is due to the complexity of the filling-forming process to cause computation of these parameters a very complicated matter. For many years, considerable hard labor has been spent by some scientists to search for methods of calculating these parameters. Related experimental equations are introduced and examined in the paper, followed by discussions on the thermodynamic problems of the filling-forming process and some conclusions with respect to computation of the aforementioned parameters and the value of their application in production.

AUTHOR: None

ORG: Mold Tool Room, Guilin Electrical Institute

TITLE: "Forming and Milling Hard Alloy Punch Mold With Single Layer Diamond Grinding Wheel"

SOURCE: Guiling MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 58-64

ABSTRACT: It is reported that in foreign countries, single layer diamond forming grinding wheel is used to finish stainless steel blade punch mold and dynamo iron core plate punch mold to a precision of 0.0075mm and a smoothness of $\nabla 8$, and each wheel may form a length of 3800mm. For the purpose of improving this technique in China, a research was carried out to study the technique of making precision diamond forming grinding wheel and to experiment with it for forming and milling hard alloy punch molds. This paper is a report of the study.

AUTHOR: CHEN Liting [7115 7787 1250]

ORG: Ningxia Helan Dynamo Plant

TITLE: "Determination of Work Precision of Dynamo Complex Mold Punch Head"

SOURCE: Guiling MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 64-68

ABSTRACT: In dynamo industry, the complex mold is an important equipment, while its punch head is the key component. Working the punch head is a long and complicated process, and its precision must be guaranteed by the various steps of the work process as well as its testing and measurement. This paper discusses mainly the aspect of guaranteeing its precision through testing and measurement. Three punch heads manufactured by the Helan Dynamo Plant are the objects of a study reported in the paper.

AUTHOR: LI Shaoqing [2621 7300 0615]

ORG: Beijing Mold Tool Plant

TITLE: "Buffing With Pressurised Flowing Milling Granules"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun p 69

ABSTRACT: In the past 2 years, researches on techniques of milling-buffing have been reported in such foreign countries as the United States, the Soviet Union, and Japan, but no technical parameters are introduced. It appears that in all these cases, power is used to cause the milling granules to be in a pressurised motion to accomplish the buffing action on the surface of various shapes. On the basis of these bits and pieces of information, the author and colleagues studied and summarised to obtain a preliminary design of a mold tool, named pressurised flowing milling granule buffer. The structure of the mold is described.

AUTHOR: HE Huayan [0149 0553 3948]

ORG: Guizhou Tractor Dynamo Plant

TITLE: "Automation of Small Dynamo Iron Core Plate Punch Press"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 70-72

ABSTRACT: The Guizhou Tractor Dynamo Plant manufactures many types of dynamo iron core plates in large quantities, more than a million plates a year of each of the major types. The author and colleagues reconstructed 2 63-ton and 1 100-ton punch machines to realize automation of such processes as material supply, joining, and sorting. They also made a small rolling cutter to cut the material lengthwise. Following the reconstruction, production practice for about a year has demonstrated that the efficiency has been improved about 50 percent while the material utilization rate has been made 10 percent higher. Improvements to the punch presses and the work procedure are described.

AUTHOR: FU Fengqiang [0265 0023 1730]
JIAO Baolin [3542 1405 2651]
CHEN Rongsheng [7115 2837 3932]

ORG: Xinanjiang Electronic Tube Plant

TITLE: "Punch Technique of Microform Welded Wave Tube Films"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 73-74

ABSTRACT: Microform welded wave tube is an elastic component made by welding 3 types of films with the micro-bundle plasma welding method. Two of the 3 film plates are of stainless steel material; the outer circle, the inner hole, and all the wave pattern of these must be concentric, and the outer circle and the inner hole must not be bristly. The authors designed a punch technique of making these film plates. The structure of the molds and the forming procedure are described.

AUTHOR: TANG Yonglin [0781 3057 2651]

ORG: Changde Textile Machinery Plant

TITLE: "Punch Press Automatic Material Drop Device"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 75-77

ABSTRACT: For the purpose of improving the quality of punch press products, reducing the cost, and improving the labor productivity, a device is designed to cause the material drop process to be entirely automatic. The characteristics of the automatic device, the scope of its application, and its major structure are discussed.

AUTHOR: XUE qixiang [5641 0796 5046]

ORG: Beijing Mold Tool Plant

TITLE: "Computation of the Drawing Work for Cylindrical Article With Protruded Edge"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 78-80

ABSTRACT: The drawing work of cylindrical articles is the simplest and representive work of extending and drawing sheet material. The technique of computing the drawing work of cylindrical article applies to that of box-shaped, cone-shaped, and other complex shaped articles as well. A correct grasp of the deformation characteristic and computation method of a cylindrical part is, therefore, extremely important for understanding the drawing process of parts of different shapes in specified conditions. In terms of qualitative analysis, the drawing coefficient for cylindrical articles with or without a protruded edge is basically the same. This paper analyses the condition of the deformation process and explains the various equations for computing the various parameters.

AUTHOR: WANG Shijun [3769 4311 0689]

ORG: Department of Tools, Second Automobile Body Plant

TITLE: "Reform of Punch Press Work Process"

SOURCE: Guilin MOJUN TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 81-82

ABSTRACT: Originally, the Second Automobile Body Plant manufactured parts with a five-step continuous punch press method. One part was produced in each punch process. The method was designed with consideration of continuous operation without waste. In actual production, several shortcomings occurred, tearing and rough cutting edge. The work process was reformed to become the current process. The new process involves a three-step continuous mold and 2 parts are produced in one punch. The original work process and the reformed work process are both illustrated.

AUTHOR: ZHOU Guanghua [0719 0342 5478]

ORG: Guangyuan P.O. Box 112

TITLE: "Measures to Reduce Increased Length in One Operation Forming of Fixing Clamp Parts"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 82-83

ABSTRACT: When clamp type parts are bent in two operations or are bent one corner at a time, there are equations to compute the length of the article when it is opened out or there may be table to find the length directly. When all 4 corners are bent in one operation, a different condition exists. The length varies and there is no reference to provide the data. The paper explains that in case of the mold of the factory to which the author is affiliated the length of the product is 1.5-3.5mm longer than its specification. This is due to the sliding action of the surface layer metal and measures can be taken to correct it. These measures and results of the improvement are explained.

AUTHOR: YU Yenhui [0827 8746 6540]

ORG: Changsha Bakelite Electrical Plant

TITLE: "Drawing Cylindrical Articles With Ordinary Single Motion Punch Machine"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 83-84

ABSTRACT: In designing the mold tool for drawing long cylindrical articles, aside from selecting the reasonable drawing coefficients, the suitable gap, and the radius of the round corner of the concave mold, the design must also be determined by the maximum closure and running distance of the punch machine. Ordinarily, the running distance must be greater or equal to twice the length of the product so that there will be no interference in removing the product. This paper explains ways of compensating for the running distance of the punch machine in case the product is too long.

AUTHOR: XU Guangcang [6079 1684 0221]

ORG: Second Gas Punch Mold Plant

TITLE: "Application of Basic Steel in Cold Work Mold Tool"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 85-87

ABSTRACT: Basic steel, such as 65Nb(65Cr4W3Mo2VNb), CG-26Cr4Mo3Ni2WV, etc. is not only highly strong; its viscosity and plasticity are also higher than high speed steel and Cr12MoV steel. The Second Gas Punch Mold Plant and others have experimented with using this type of steel to make cold squeeze press concave molds, thick hard plate punch molds, and cold stamp molds which generally crack and break easily, for the purpose of increasing their useful life. The results have been positive. The data of two such experiments are described.

AUTHOR: GAO Jintian [7559 0093 3944]

ORG: Dalian College of Engineering

TITLE: "Forms of Damages in Hot Mold Tools and Ways of Increasing Their Useful Life"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 2, 15 Jun 79 pp 88-94, 84

ABSTRACT: Factors influencing the useful life of mold tools are mainly the reasonableness of the structural design, repair and maintenance of the mold in the operation process, including lubrication, preheating, etc., selection of materials, quality of workmanship, annealing effects, and so forth. The forms of damages include mechanical abrasion, heat fatigue cracks, oxidization, contact fatigue, etc. This paper explains at length various ways of preventing these damages for the purpose of prolonging the useful life of hot mold tools.

AUTHOR: YIN Daiyue [3009 1486 1947]

ORG: Hangzhou Camera Plant

TITLE: "One Operation Edge Cutting Mold of Pulled and Extended Article of Unequal Height"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 1-3

ABSTRACT: The 135 camera produced by the Hangzhou Camera Plant has a cover wich is a rectangular piece of pulled and stretched article. After cutting, it is necessary that its height is different in all 4 directions. Originally, it was accomplished by using 7 molds, four to cut the edige of the 4 sides and the remaining to cut the corners in 8 work processes. After these, the article still requires milling and its size remains less than precise. A new work procedure has been introduced to use a 63 ton punch to perform all 8 steps in one operation. This new mold has saved time as well as improved the quality. The structure of the new mold is described.

AUTHOR: ZHENG Haijin [6774 3189 6855]
HUANG Xuanjun [7806 1357 0193]

ORG: Both of Mold Tool Designing Group, Shanghai Electrical Meter Plant

TITLE: "Two-Work-Position Horizontal Automatic Input Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 3-6

ABSTRACT: The Shanghai Electrical Meter Plant produces 600,000 probe heads per year out of copper plates covered with silver. In the past, 2 sets of molds were used in 2 steps of material input and bending. The productivity was low, while the material input mold did not last very long and the quality of the products was poor. In 1973, during a citywide movement to promote punch machine automation, the authors designed a two work position horizontal advancing punch mold, with which material input and bending are accomplished in one set of mold tool. Practice since then has proved that the mold life is long and the work efficiency is 10 times higher. More than 200,000 pieces may be produced before the blade requires shapening again. The work principle and the structure of the mold tool are described.

AUTHOR: LIANG Bo [2733 3134]

ORG: Guilin Lijiang Machinery Plant

TITLE: "Pleated Mold for Forming Waveguide"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 6-9

ABSTRACT: At the Lijiang Machinery Plant, curved waveguid was originally formed by bending sheet steel. It was a labor intensive work and the products were far from satisfactory. A 16-ton punch machine was later reconstructed specially for the purpose of making this waveguide. A mold with pleats was designed to depend upon the pleats to produce an uneven metal creep, which causes the straight pipe to gradually bend on one side. Ater the pipe is bend into the desired shape, it is cut to produce a trapezoid profile. The structure of the mold tool, its design and manufacturing process, and its performace are discussed.

AUTHOR: LI Bingrong [2621 3521 2837]
WANG Huifen [3769 1979 5358]

ORG: Shanghai Huaguang Zipper Plant

TITLE: "Edge Cutting Continous Step Advance Forming Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 10-11, 9

ABSTRACT: For the purpose of quickly developing China's nonmetal zipper industry, the Shanghai Huaguang Zipper Plant researched on a spiral type nylon zipper to cause it to become a priority product. This zipper has a spring safety lock which qualifies it as a product of high quality. The continuous step advance mold cuts the edges automatically and is designed to work with ordinary 5 or 8 ton crank punch machines. The mold structure and the major motions of the mold are described.

AUTHOR: None

ORG: Punch Press Group of Department of Tool Assembly and Experimentation Team of the 42 Machine Shop, State-operated Omei Machinery Plant

TITLE: "Punch Mold for Small Holes on Thicker Material"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 12-13

ABSTRACT: The part is to be made of Cr 8Ni9Ti material of a thickness of 0.5mm and it has a total of 9 small holes of a diameter of 0.4mm, which is not as thick as the material. Due to the fact that the Omei Machinery Plant does not have a small punch machine, the mold is designed for a hand press, a pneumatic press, or a table drill press and to be operated manually. The specifications of the product and the design and production procedure of the mold are given.

AUTHOR: ZHANG Tubi [1728 0956 1084]

ORG: Xi'an Machinery Plant

TITLE: "Pressure Extension Mold With Cone-shaped Edge Pressing Ring"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 14-15

ABSTRACT: The pressure extension mold with cone-shaped edge pressing ring is reconstructed from an ordinary pressure extension mold. The degree of deformation may be raised about 20 percent. The pressure extension is accomplished in 2 operations. The technique of reconstruction is described. There are drawings depicting the pressure extension process, the convex portion of the mold, and the 2 operations.

AUTHOR: LIU Jinzhong [0491 6855 1813]

ORG: Punch Press Machine Shop, Xuchang Relay Plant

TITLE: "Relay Magnetic Yoke Plate Cut and Polish Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 15-16

ABSTRACT: The requirements of the code relay magnetic yoke plate produced by the Xuchang Relay Plant include a △6 smoothness of the terminal surface and a $75.5^{+0.15}$ mm measurement from the curve to the terminal surface. In the past, it was finished by milling. The work efficiency was low and the quality was not easily maintained. Later a mold was designed to finish it on a 25 ton oil press. The work efficiency and the quality of the product improved a great deal. The work theory and the mold structure are explained. Outstanding problems and important items in the work process are discussed.

AUTHOR: CHEN Changqian [7115 7022 6197]

ORG: Sichuan Leshan Mining Machinery Plant

TITLE: "Forming Strickle Board Conveyor Grooved Barn With Single Groove Mold Punch Press"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 17-18

ABSTRACT: The grooved barn is an important part of the SGWD-17 strickle board conveyor. At present, most manufacturers adopt the one operation forming technique to make it. This is rather difficult to do for small factories without a 400 ton compressor. The Sichuan Leshan Mining Machinery is such a small factory. The author and colleagues designed a set of single groove mold tool, which can be used on 65 ton hydraulic press to form the grooved barn. It takes 4 operations to complete this article. The structure of the mold and the procedure of using it to produce the desired article are explained with illustrations.

AUTHOR: WANG Kejian [3769 0344 0313]

ORG: Second Machine Shop, First Branch Plant, Zhengzhou Automobile Manufacturing Plant

TITLE: "Hole Punch Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 p 19

ABSTRACT: The ZZ-130 beam produced in the Second Machine Shop has 3 holes which are made with punch mold in the 100 ton press. In the beginning, 2 sets of molds were used to complete it in 2 operations. Later, one set of mold, as depicted in a figure included in the paper, was designed to finish it in one operation. The labor intensity was greatly reduced while the work efficiency more than doubled. The mold is suitable for plants with no large equipment and small quantity of parts production.

AUTHOR: None

ORG: Dongguan County Dynamo Plant

TITLE: "Improvement to the Material Drop Board"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 p 20

ABSTRACT: In the process of making the mold tool for the dynamo, it had come to the attention of the authors that if the structure of the material drop board was made reasonable, the useful life of the mold could be greatly lengthened. The original one is a board structure, fastened onto the concave mold to allow the material to slide under it. The shortcoming is the fact that it provides no support to the convex mold to cause it to receive side pressure so as to become bent or deformed. Under normal use, the blade had to be sharpened after less than 10,000 operations. The authors changed the board into a bridge shape, composed of the 3 parts of material drop frame, directional plate, and a roller guide cover. After the improvement, the highest record is 120,000 operations before sharpening. Each mold lasts as long as 2-3 original molds, while the cost of making the mold is about 150 yuan higher.

AUTHOR: ZHOU Bohe [0719 0130 0735]

ORG: Xingan Post and Telecommunications 532 Plant, Guangxi

TITLE: "Pressure Bending of Tin Bronze"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 p 21

ABSTRACT: Tin bronze is a material of good elasticity. It is commonly used to make elastic parts, but it is rather difficult to design and make its pressure bending mold because the material has a great capacity of springing back. It also belongs to the solid solution type metals, with no phase change after being heated to cause the process of annealing, pressure bending, and quenching to be not applicable. The author and colleagues found a method of using it for the spring for a ferrous oxide installation. The method involves a specially designed cog mold. The mold and the technique are briefly introduced.

AUTHOR: TAO Qixu [7118 0366 4872]

ORG: Chengdu City 378 Mailbox Tool Department

TITLE: "Simplification of Design Computation for Stretching Rectangualr Box"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 22-24

ABSTRACT: The Chengdu City 378 Mailbox Tool Department produces a rectangualr box. According to the cold press handbook, there are equations for step by step computation. The equations are numerous and the resultant computation data are often not very reliable. This paper proposes a simplified method to compute the work procedure. The complete simplified computation process is given.

AUTHOR: WANG Yimin [3076 3015 3046]

ORG: Dongan Machinery Plant

TITLE: "A Disk To Locate the Gap Between the Concave and the Convex Molds of the Punch Cut Mold Tool"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 25-26

ABSTRACT: In designing punch cut mold tool, the computation is rather simple to determine the gap between the concave and the convex molds,but it is still necessary to find related information in references or tables. This paper presents the design of a rotating disk, which can be easily made with cardboard or a piece of plastic. The method of making and using the disk is described. After it is made, the disk can be carried in the pocket and the gap may be located without computation.

AUTHOR: WANG Honggang [3769 3163 4854]
YANG Guisheng [2799 2710 3932]
LI Chaoming [2621 2600 2494]
LIN Jianhua [2651 1696 5478]
LIU Yi [0491 0034]

ORG: WANG, YANG, LI, LIN of Kunming College of Engineering; LIU of Yunnan Bearing Plant

TITLE: "Stress Analysis of Bearing Ring Thermal Punch Press Mold Tool"

SOURCE: Builin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 27-33

ABSTRACT: This paper investigates the reason for early damage of molds from the viewpoint of stress analysis. The closed punch mold of the inner ring of 7909 bearings are selected on the basis of relatively severe early damage phenomenon as the objects of analysis using resistance strain measurement, model test, and limited units calculation. It is discovered that during punch operation, a stress concentration region appears at the neck of the mold. This is the basic reason for the head of the mold to break off. Based upon this result of analysis, measures are adopted to eliminate the problem. Production practice has preliminarily verified the obvious effectiveness of the measures.

AUTHOR: CHEN Shiqing [7115 0013 3237]

ORG: Shanghai People's Electrical Plant

TITLE: "Brief Introduction of Material Feed Device: Roller Style Material Feed Device"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 34-37

ABSTRACT: The roller style material feed is the most extensively used type among all material feed devices. It is used in rolled or strip materials, and is divided into the single edge and the double edge types. The single edge type mostly pushes the material forward, while the double edge type pushes and pulls materials simultaneously. Drawings are included in the paper to depict the structure and components of several types of roller material feed devices.

AUTHOR: TAN Derui [4405 1795 4213]

ORG: Shanghai Meter Instrument Casting and Forging Plant

TITLE: "Concerning Problems of Precision of Size and Quality of Surface of Ceramic Cast Articles"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 38-46

ABSTRACT: At present, ceramic type casting procedure is not extensively applied in China mainly because the size of the articles is less than precise, the quality of the surface is not high, and the useful life is not stable. These are also the reason why the industry remains small scale manual production. This paper combines the results of nearly a decade of experiments and production with domestic and foreign reference data to discuss some viewpoints and understandings concerning the problems of size and surface quality. Factors contributing to the 2 problems and possible solutions are suggested.

AUTHOR: ZHANG Zongliang [1728 1350 5328]

ORG: Electrical Processing Team, Northwest Coal Mine Machinery Second Plant

TITLE: "Eliminating Lateral Surface Dent in the Forge Mold Gas-filled Electrolysis Mold Cavity"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 47-48, 46

ABSTRACT: Dents in the side surface of the mold cavity is a relatively common problem of gass-filled electrolysis forge mold. They seriously affect the precision of forming. The Northwest Coal Mine Machinery Second Plant adopted the work process in 1976 and such dents have occurred in 3 types of the forge molds. This paper analyzes the causes of these dents and experiments with ways of eliminate their occurrence.

AUTHOR: GAO Yongkuan [7559 3057 1401]

ORG: Jinan Automobile Manufacturing Plant

TITLE: "Use and Maintenance of Forge Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 49-50

ABSTRACT: The forge mold receives a great and complex dynamic load in the operation process, with complicated shear, tensile, and compression stress. On the surface of the mold cavity, there is the action of deforming metal flow to produce violent relative friction. In the cooling and lubricating process, there are violent expansion and contraction due to fast and great temperature difference. These are the reasons for the mold to be damaged very fast, including partial collapse, size deformation, cracks, and breakage. Proper ways of using the molds and taking care of them can definitely prolong their useful life, however. The measures adopted by the Jinan Automobile Manufacturing Plant in the use of protection of the molds are introduced.

AUTHOR: ZHANG Shijiang [1728 0013 3068]

ORG: Nanchang Refractory Materials Plant

TITLE: "Investigation of the Computation Equations for the Friction Resistance Between Powder and the Mold Wall"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 50-52

ABSTRACT: The Powder Metallurgy Mold Design Handbook recommends, for calculating columnar body friction, the following equation: $F = f\xi p_{up} LH = t\xi p_{up} S$ side. It is applicable when the unit pressure p in the various points is not greatly different. It is not suitable when there is an excessively long and narrow place on the cross-section because under that condition, p is not a constant. This paper investigates the problem of calculating friction F when there is an excessive length and width ratio or an excessively long and narrow place on the cross-section.

AUTHOR: NI Mingyi [0242 2494 0001]

ORG: Beijing Institute of Powder Metallurgy

TITLE: "Comparison of Two Types of Friction Calculation in Powder Press Work"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 52-54

ABSTRACT: After reading the Paper "Investigation of the Computation Equations for the Friction Resistance Between Powder and the Mold Wall" by ZHANG Shijiang, the author believes that ZHANG's conclusion is correct, and wishes to thank ZHANG for this valuable supplement to the Handbook, of which the author is a member of the editorial board. Furthermore, the author proposes his own views on the practical value of the approximation equation given in the Handbook. The paper proceeds to compare the 2 equations in question.

AUTHOR: DAI Jiliang [2071 0679 0081]
TANG Shengen [0781 3234 2704]
ZHAO Yunjie [6392 0061 7132]

ORG: None

TITLE: "Design of Slanted Guide Post Coring Machine"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 55-61

ABSTRACT: Moveable blocks or pieces must be used to form raised and indented shapes and holes on the side of plastic products and these pieces must be removed before the product is separated from the mold. The machine used to perform the operation of removing these pieces and putting them back in place for the next operation is generally called a coring device. The most commonly used coring device is the slanted guide post coring machine. This paper discusses its structure at length. Ways of permanently installing the coring device so that it may be deftly and reliably used are also explained.

AUTHOR: WANG Zongliang [3076 1350 5328]

ORG: Shanghai Plastic Products Mold Tool Plant

TITLE: "Technique of High Pressure Injection With No Loose Edges"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 62-63

ABSTRACT: When plastic products are formed by injection, loose edges often occur to cause it necessary to be worked over. The production time is thus increased, productivity reduced, and the quality of the products is poorer. The common technique of eliminating the loose edges is to lower the injection pressure, but many shortcomings, such as dents, missing pieces, and poor welding, occur when the pressure is low. The author experimented in the production process with raising the pressure on the mold tool to resolve the problem of loose edges and produced fairly satisfactory results. In the paper, the reasons for the loose edges to occur and the theory and method of eliminating them are analyzed. Samples of using the new measure to resolve the problem are given.

AUTHOR: TING Weiqiang [2079 0251 1730]

ORG: Hefei Radio First Plant

TITLE: "Injection Plastic Mold With Positive and Reverse Coring"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 64-65

ABSTRACT: If a mold tool is to guarantee successful forming of the plastic product as well as accomplishing high productivity and low production cost, it is necessary to complete the forming process in one operation to avoid the need of working the products over after forming, as much as possible. With molds of complex shapes, there are forming components inside the mold that are moveable and they are often in the way to prevent the product from being separated from the mold freely. The Hefei Radio Plant produces a radio which has a black polystyrene case with holes of different geometric shapes on its sides. This paper describes the technique of designing the mold and the coring device to accomplish the objective of finishing the case successfully in one operation.

AUTHOR: DIAO Shusen [0431 2885 2773]

ORG: Harbin Plastic Material Machines and Mold Tools Plant

TITLE: "Checking and Testing the Maximum Needed Force for Locking the Mold in Injection Molding of Plastic Materials"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 4, 15 Dec 79 pp 65-67

ABSTRACT: When plastic material is being injected into the mold under high pressure, an expanding force occurs along the surface of the shape in the mold. The maximum force for locking the mold should be less than the designated mold locking force of the injection machine, otherwise, the material will leak all along the surface to cause spilling. With molds having no symmetrical axes on the cavity projection area, the level of the injection machine will receive unbalanced force to cause the injection machine mold locking force to be reduced and the machine to suffer abnormal wear. This paper explains the technique of avoiding such shortfalls during the process of designing the mold tool and the method of calculating the maximum locking forces.

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CSO: 4009

AUTHOR: ZHANG Dingcheng [1728 7844 2110]
LU Shichang [7120 1102 2490]

ORG: None

TITLE: "Comments on the Computation Equations for the Slated Guide Post Coring Device"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 1-8

ABSTRACT: Further investigation appears to be warranted with respect to the computation equations for the slanted guide post coring device given in several books currently in print. A list of them is included at the end of this paper. [All are Chinese publications.] In separate sections, the authors present their viewpoints on (1) Computation of the coring force; (2) Computation of the moment of bending force of the slanted guide post; (3) The relationship between the coring distance and the running distance of the open mold; (4) Determination of angle of the locking wedge; (5) The position of the slanted guide post separating block.

AUTHOR: LI Jiguang [2621 4949 0342]

ORG: None

TITLE: "Investigation of Computation of Wall Thickness of Rectangular Plastic Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 8-11

ABSTRACT: In manufacturing plastic products, the design and construction of the mold tools form one of the important links. It is a common headache of the industry to have bristly surface on the products. This shortcoming is also called flying edges. Considerable labor must be consumed to remove the bristles and the quality and appearance of the product are affected as well. The shortcoming is related to the reasonableness of mold design. The elastic deformation of the mold cavity causes the bristles to occur easily. If the expansion of the mold during elastic deformation under pressure exceeds 0.06-0.07mm for polystyrene and 0.02-0.03mm for nylon materials, bristles will occur. This paper explains the method of calculating the plastic deformation of rectangular mold cavities for the purpose of acquiring a reasonable design for eliminating the shortcoming of flying edges in the products.

AUTHOR: HU Jiaqi [5170 1367 7871]

ORG: Meicheng Electrical Plant, Jiande County, Zhejiang Province

TITLE: "Graphic Technique for Computing Forming Size of Molds For Phenolic Plastics"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 11-13

ABSTRACT: Phenolic plastics have good insulation property, mechanical strength, stable product size, good heat resistance, and beautiful appearance; they are also easy to form and low cost; therefore, they are extensively used in electricals and common consumer goods. At present, the technique of forming with phenolic plastic powder has developed from pressure forming to injection forming with resultant increase of productivity close to 8 to 10 times to provide good prospects for automation. The equation for calculating the forming portion of the mold involves addition, substraction besides multiplication to cause the slide rule to be insufficient for the purpose. This paper introduces a graphic technique of computation. The graphs and sample calculation using the graphs are included.

AUTHOR: None

ORG: Design Group, Tool Machine Shop, Shanghai Switch Plant

TITLE: "Understandings in the Designing of Thermal Solidifying Plastics"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 14-19

ABSTRACT: Thermal solidifying plastic material injection molds have higher productivity than thermal pressure forming molds. Their advantages also include stable quality, low labor intensity, and long useful life. The Shanghai Switch Plant now has more than 20 sets of such molds in production; their productivity is 3-5 times that of the old fashioned molds they replaced. Important factors in the designing of the injection molds are discussed, including various inserts.

AUTHOR: YANG Xianse [2799 0341 3419]

ORG: Work Technology Department, Zhuzhou Xiangjiang Machinery Plant

TITLE: "Fluorine Plastic Material Mold Tool Design"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 20-25

ABSTRACT: Fluorine plastics are relatively new thermal plastic materials. They are being more extensively applied everyday here and abroad in defense industries, electronic industries, food industries, and pharmaceutical industries. This is due to the fact that the carbon-fluorine bond is stronger than carbon-carbon bond to cause fluorine plastics to have superior resistance to high and low temperatures, abrasion, and weather, and they also have insulating, non-absorbent, and low abrasion characteristics. These advantages are especially apparent in polytetrafluoroethylene (F-4). This paper introduces the mold design for the F-23-19 protective belts produced by the Xiangjiang Machinery Plant. The selection of materials to make the mold and the determination of the size of the form cavity of the mold are also discussed.

AUTHOR: None

ORG: Designing Group, Work Tool Department, Shanghai Switch Plant

TITLE: "Automatic Reset of Push Lever Mechanism of Plastic Material Mold Tools"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 25-26

ABSTRACT: In the process of production of plastic articles, if the product must be pushed out by a lever, the device is called push lever. If a reverse lever is added to close the mold and to cause the push lever to return to its original position, the device is called push lever reset. This paper describes an automatic reset for the push mechanism designed by the group to manufacture the rain cover for the high voltage switch 110KV. The work theory of the automatic device is explained.

AUTHOR: LU Shichang [7120 1102 2490]

ORG: Shanghai Electrical Meter Plant

TITLE: "Injection Mold of Micro-thin Type Plastic Articles"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 27-30

ABSTRACT: Technical problems with respect to micro-thin plastic article molds include the work aspect and the injection aspect. The former includes the difficulty of placing inserts into the small cavity with tweezers while minor vibration may cause the inserts to be displaced, etc. The latter includes the difficulty of adding fillers while the plastic material sticks to the mold and becomes broken easily. This paper introduces various methods of resolving these problems. In a separate section, structures of several simple micro injection molds are given and explained to illustrate the methods discussed.

AUTHOR: DIAO Shumen [0431 2885 2773]

ORG: Harbin Plastic Material Machinery Mold Plant

TITLE: "Foating Style Plastic Material Injection Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 31-32

ABSTRACT: With the development of plastics industry, injection molds are growing in the direction of precision, large size, and automation. Large volume machines capable of injecting several kg to several tens of kg have appeared, weighing as much as several tons. With large size articles, problems of eccentricity of the form core and form cavity, uneven wall of the mold, etc. occur easily to cause the size of the product to be not precise. This paper proposes a floating style mold tool to resolve the problem of insufficient strength of the core and supplement errors of assembly, as well as to correct mold cavity eccentricity causedby heat expansion difference due to temperature differential, and other errors. The design theory and the structure of the floating style mold tool are explained.

AUTHOR: HE Xinglin [0149 2622 2651]
HAN Lun [7281 0243]

ORG: Both of Tianshui Changcheng Low Voltage Electrical Instrument Plant

TITLE: "Improvement to the Vertical Shape Separation Structure of Mold for Plastic Materials"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep pp 32-33

ABSTRACT: At present, in making plastic material injection molds, some plants adopt the inclined plane mold division structure with triangular separating blocks. Due to the fact that the final assembly of the triangle depends upon manual adjustment with a pair of tweezers and that the triangle piece must be assembled before heat treatment, it is difficult to prevent the piece from being deformed during the heat treatment. In some cases, when the mold is opened, accidents occurred and when the causes were analysed the accident often appeared to be related to the unsatisfactory load condition of the inclined plane in the mold. With detailed computation and illustrations, this paper reports the method and procedure of improving the structure to eliminate several shortcomings and to prevent the occurrence of accidents.

AUTHOR: None

ORG: Department of Work Tools, Tianshui Changcheng Electrical Instrument Plant

TITLE: "Moveable Mold Coring Wire Connecting Terminal Injection Plastic Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 p 34

ABSTRACT: The wire connecting terminal produced by the Changcheng Electrical Instrument Plant has a relatively complicated shape. The wall is thin, only 0.5mm in thickness. Coring is required from the front as well as the side. Taking into consideration these special characteristics, the authors adopted a moveable mold coring structure to prevent the phenomena of torn or deformed products. Due to the excessively thin wall of the product, the phenomenon of unsatisfactory joining of the walls occurred frequently at first. The authors added an exhaust groove at the place of the thin wall and overcame this shortcoming completely.

AUTHOR: SHEN Zhiguo [3088 3112 0948]

ORG: Shanghai Changhong Machine Parts Plant

TITLE: "Simple Plastic Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 35-36

ABSTRACT: The Shanghai Changhong Machine Parts Plant uses simple plastic material mold tool to form engineering plastics from polyethylene, ABS, polycarbonate ester, polysulfones, and nylon. The simple mold has pour opening material drop and is supported by a general purpose mold frame. The products include electromagnetic valve sealing plate, etc. The finished product is removed from the mold manually. The advantage of this simple mold is that it takes about 8-16 hours to make a set and the cost is low. It is also very adaptable to new product variations to allow new products to be quickly in production. The shortcoming is the fact that the job performed by the worker is very hard.

AUTHOR: JIN Ranxing [6855 3387 5281]

ORG: Shanghai Third Switch Plant

TITLE: "Understandings in the Designing of Mold Tools For Polycarbonate Ester Parts With Thin Walls"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep p 37

ABSTRACT: Although polycarbonate ester has many good properties, its melt temperature and viscosity are high and flow property is low to cause it difficult to form parts of complicated shapes or with thin walls. Generally the walls of the parts made of that material is no thinner than 0.9 [mm], but if the wall is thinner than 0.9[mm] but the height is not great, it will still be possible to make relatively satisfactory parts. This paper reports the effort of the author and colleagues to use this material to make power leak switches with thin walls. Their experience in designing the mold tool is introduced.

AUTHOR: ZHOU Bohe [0719 0130 0735]

ORG: Guangxi Xingan Post and Telecommunications 532 Plant

TITLE: "Civer Injection Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 p 40

ABSTRACT: The machine produced by the Xingan Post and Telecommunications 532 Plant has a cover; there is a No.5 rim all around it. It is, therefore, difficult to form it with ordinary methods. In consideration of the structure, the author and colleagues adopted the method of forced separation from the mold by a 2-step pushing action. The result has been satisfactory. The structure of the mold is described.

AUTHOR: SHEN Wenxue [3088 2429 1331]

ORG: Shanghai Electric Welding and Dynamo Plant Plant

TITLE: "New Structure of Plastic Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 38-39, 36

ABSTRACT: This paper explains a new structure of molds for plastic materials. The mold is composed mainly of a stationary portion, the moveable portion, the bearing lever mold separation device, the device for direction guidance, mold pull, and distance fixing. With detailed drawings, the 4 major portions of the mold tool are explained.

AUTHOR: LI Shunhe [2621 7311 0735]

ORG: Department of Science and Technology, Nanjing Navigation Instrument Plant

TITLE: "Rotary Plug Injection Plastic Mold"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 p 41

ABSTRACT: The XS-ZY60 horizontal plastic material injection machine is used with the rotary plug mold for producing nylon plugs. The mold has 8 components, and the screw thread on the plug is cut automatically. The productivity of the mold is high, the quality of the products is good, and the tool is suitable for automation. The complete structure of the mold is explained.

AUTHOR: WU Fujun [0124 4395 6874]

ORG: Xinguang Machinery Plant

TITLE: "Standardization of Frames for Plastic Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep pp 41-43

ABSTRACT: In the work process of forming with plastic materials, the important link is the mold tools, which have complicated structures, requiring high precision, high smoothness, and being difficult to make. Aside from the need of adopting some advanced techniques such as cold pressed cavity, electrical milling, electrical corrosion procedure, etc. or using such materials as epoxy resin, glass fibers, colored metals, etc. to form the mold cavity quickly, for the purpose of shortening the cycle of mold tool manufacture, standardization of mold tools is also an important condition. In China, standards suitable for the forming of thermal solidifying plastics were established in the 1950's. In the 60's, varieties of thermal plastics grew while types of injection machines with different specifications also appeared. New standards are therefore needed. Based upon the current equipment at the Xinguang Machinery Plant, the author and colleagues established a standard frame for molds, suitable for certain thermal solidifying plastic molds and certain standing injection molds. The structure of the frame is explained.

AUTHOR: LIU Dingbang [0491 1353 6721]

ORG: Guilin Electrical Meter Plant

TITLE: "Frame for Quick Loading and Unloading of Bakelite Molds"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 44-45

ABSTRACT: For the purpose of reducing labor intensity of the workers, conserving electrical power, and shorten production time, it is important to adopt a general purpose mold frame. This paper reports a design of a general purpose mold frame designed and made by the author and colleagues in 1971. Since then, good technical and economic effects have been obtained. The structure and work theory of the mold frame are explained.

AUTHOR: ZHU Xueshi [2612 1331 1807]

ORG: Jiamusi Dynamo Plant

TITLE: "Standardization of Insertion Style Round General Purpose Mold Frame for Pressure Forming of Thermal Solidifying Plastics"

SOURCE: Guilin MOJU TONGXUN [NEWS REPORTS ON MOLDS] in Chinese No 3, 15 Sep 79 pp 46-48

ABSTRACT: For the purpose of meeting the needs of experimental manufacture and small batch production, the Jiamusi Dynamo Plant adopted a standardized round general purpose mold frame to shorten the time used to design mold tools. The frame is simple to make; the cost of making it is low, but it is convenient to use and easy to set up because of its small volume. The structure and the procedure of application of the standardized mold frame are explained.

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CSO: 4009

AUTHOR: WANG Zhemou [3769 3074 5399]

ORG: None

TITLE: "Inspiration from Marine Animals"

SOURCE: Beijing HAIYANG [OCEANS] No 11, 12 Nov 79 pp 4-6

ABSTRACT: The author reviews some human inventions and developments that were direct imitations of marine animals' organs and functions, namely: 1) in shipping, development of oars and sculls that simulate fish tails, rudders that simulate fish fins, and improvement of shipping speed by simulating the external shape and skin structural characteristics of fast swimming whales and dolphins; 2) Roth's invention of artificial gills that simulates the structure and function of gills; and 3) development of storm forecasting instrument that simulates the conversion of subsonic waves into electric pulse in jellyfish ears and kingcrab eyes, and the sharpening of TV picture outlines and improving of radar sensitivity by application of the traverse inhibition principles of kingcrabs. The article is to be continued.

AUTHORS: HUANG Xuefan [7806 7183 5400]
ZHU Yufeng [2612 3768 7685]

ORG: None

TITLE: "Offshore Earthquakes in China"

SOURCE: Beijing HAIYANG [OCEANS] No 11, 12 Nov 79 pp 13-15

ABSTRACT: The authors review and analyze the recordings of occurrence and intensity of earthquakes along the coasts and offshores from northern, central and southeastern China to southern China that show the uniqueness and continuity between the continental earth crust and the offshore earth crust, and therefore belonging to a similar earthquake system. Furthermore, occurrence of destructive earthquake tsunami has also proved to be unlikely or seldom, because of its shallow water, simple topography, and shields of islands. Finally, the significance of such omens of offshoe earthquake as sea level anomaly, sea illumination anomaly, marine animal anomaly, sea bird migration, sea water salinity anomaly and ocean climate anomaly are discussed.

AUTHORS: LIN Yuefu [2651 1471 1133]
ZHOU Qiulin [0719 4428 7792]

ORG: None

TITLE: "Hazard of Petroleum Pollution to Marine Organisms"

SOURCE: Beijing HAIYANG [OCEANS] No 11, 12 Nov 79 pp 18-19

ABSTRACT: The authors discuss the hazard of petroleum pollution, even at very low levels, to the fatality, propagation and growth of such marine organisms and their larvae as the echinodermal sea urchins, starfishes and sea slugs, benthic clam worms and worms, molluscan mussels, clams, blood clams and leeches, as well as benthic shrimps and crabs. While attributing the hazard as due mainly to suffocation from oxygen deficiency, it is pointed out also that such factors as the types of hydrocarbons, their concentrations and duration of contact, and the living habits and characteristics of the organism should also be considered.

AUTHOR: TANG Yunqluan [0781 3057 7019]

ORG: None

TITLE: "Ocean Oil Pollution and Marine Microorganisms"

SOURCE: Beijing HAIYANG [OCEANS] No 12, 12 Dec 79 pp 10-12

ABSTRACT: Following a review on the ever increasing incidences of ocean oil pollution, and its principal toxic and carcinogenous constituents, the author discusses the existance of the more than 100 species of bacteria in the oceans that are capapble of decomposing and degrading the alkanes and olefines of petroleum through alcohols and acids into carbon dioxide and water. The bacteria mentioned in this respect includes Pseudomonas, Nocardia, Micromonospora, Bacterium, Myxobacterium, Desulfovibrio and Actinomycetes. The significance of selecting and culturing such highly efficient petroleumdecomposing bacterias for the treatment of petroleum-containing sewage is finally stressed.

AUTHOR: ZHOU Hai (0719 3189)

ORG: None

TITLE: "Future Fishing Submarine"

SOURCE: Beijing HAIYANG (OCEANS) No 12, 12 Dec 79 pp 29, 24

ABSTRACT: The author envisions the development of fishing submarines for deep water fishing. These fishing submarines may possibly be constructed mainly of a sturdy spherical or semispherical pressure-withstanding shells drawing a fishing net at the tail, and fully equipped with modern sophisticated electronic devices. The speed of the submarines should be faster than those of fishes, or a minimum of 20 knots. Once the shoals are detected by sonar or underwater TV, and the submarine is within reach of the shoals, the control system will open the fishing net automatically, and then close automatically when the net is filled with fishes. Illumination devices, supersonic waves and anode fields may be incorporated to attract the shoals.

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CSO: 4009

AUTHOR: XU Deshen [1776 1795 0524]

ORG: None

TITLE: "Ocean Floor Cities of the 21st Century"

SOURCE: Beijing HAIYANG [OCEANS] in Chinese No 1, Jan 80 pp 1-2

ABSTRACT: In China, there have been tales of palaces on the bottom of the sea for many centuries. In France, the legend says that Alexander the Great stayed 100 m below the surface of the sea for 80 days in 350 B.C. These stories reflect the wishes of the hard working peoples of ancient times and the attraction the ocean had for them. Early in the 20th Century, proposals of building submarine houses by engineers never materialized. Living quarters under water became a reality only in the beginning of 1960's in France where 2 oceanographers lived and worked for 8 days under 10.5m of water. A submarine system conducted underwater experiments in Jun 1963 in the Red Sea. The shallow sea is perfectly suitable as a garden to cultivate marine organisms for food. Under water petroleum reserves may someday be extracted directly without the construction of platform or artificial island. The paper gradually leads to the notion that many pressure-resistant spheres just might really be build on the ocean floor in the 21st Centuryto form self-sufficient cities.

AUTHOR: WANG Lushan [3769 7216 3790]

ORG: None

TITLE: "Military Value of Dolphins"

SOURCE: Beijing HAIYANG [OCEANS] in Chinese No 1, Jan 80 p 29

ABSTRACT: During the WWII many oceanographers discovered many useful characteristics of the sea animal dolphin. After the war, the United States Navy has been continuously experimenting with the use of dolphins in military activities. At present, foreign researches concentrate primarily on the skin structure and the hearing organ of dolphins. Compared with tugboats, when navigating at the same speed the energy consumption of the dolphin is only 1/7 of that of tugboat. According to reports of foreign journals, the U.S. navy is raising a large quantity of dolphins. A device is tied on a dolphin's head to transmit signals of frogmen. Dolphins are being trained to detect torpedoes, to watch over bridges, and to escort small submarines and frogmen. Aside from dolphins, the United States navy has also decided to allow sea lions etc. to serve in the military. The paper is a translation of an unnamed paper of an unknown origin.

6248
CSO: 4009

AUTHOR: SHI Nian [4258 1819]

ORG: None

TITLE: "On the Importance of High Energy Physics Experiments"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 1, Mar 79 pp 9-10

ABSTRACT: This paper reviews briefly the history of development of high energy physics, starting with the discovery of neutron and positive electron in 1932, through a Japanese physicist's prediction of the existence of a particle with 200 times the mass of electron--π meson in 1935, the development of high energy accelerator before and after 1959 in Western Europe and the United States, the proposal of the quark model (called straton in China) by the theoretical physicist Gell-Mann of the United States, the discovery of J particle by the United States citizen Chinese experimental physicist DING Zhaozhong [0002 5128 0022] in 1974, etc. to demonstrate that the development of high energy physics is inseparable from experiments. In natural sciences, theory must be examined by experiments before it can be acknowledged by people. The paper concludes with the acceptance speech of Ding Zhaozhong before the Nobel Prize Committeeand the determination of Chairman HUA to establish a modernized high energy physics experiment foundation in China within the next decade.

AUTHOR: XIE Jialin [6200 1367 7782]

ORG: None

TITLE: "A General Discussion of Design Ideas of High Energy Accelerators (I)"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 1, Mar 79 pp 14-16

ABSTRACT: High energy accelerators are gigantic things. It requires complex technology and precision. Its research and manufacture need the investment of gigantic amount of manpower, materials, and money. This type of scientific research engineering should only proceed under the guidance of certain design ideas and the correctness of these ideas is obviously the key problem to whether the project can be accomplished in large quantities, fast speed, and good quality. The designing of an accelerator has 3 indispensable aspects, i.e. experiment, theory, and computation, while the design ideas are controlled simultaneously by economic limitations and limitations of quality and property. The safety parameters should also be considered as well. This paper analyses all these aspects of designing a high energy accelerator and lists items to avoid and to adjust so as to obtain an optimal design idea for a high energy accelerator.

AUTHOR: YUAN Tongse [7086 0681 3419]

ORG: None

TITLE: "History of Development of High Energy Physics Experiments (VI)--Particle and Antiparticle"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 1, Mar 79 pp 17-19

ABSTRACT: By the 1920's there had been only 3 types of known basic particles; i.e. electron, photon, and lastly proton which is the nucleus of hydrogen. Since the 1920's, the development of quantum mechanics promoted the development of particle physics. The contribution to the discovery of positrons by the English physicist Dirac and the American physicist Anderson [Carl David] in the 30's, and the discovery of neutron by Chadwick of England are related. Following the discovery of positron, which is the antiparticle of electron, a wave of looking for antiparticles began and it was presumed that nucleons should also have their antiparticles. In 1955, antiproton was finally discovered by the American physicist Segre. Since 1947, many so-called strange particles have continuously been discovered. As physicists continue to look for antiparticles the question of whether or where there exists antimatter becomes one of the subjects of modern scientific research.

AUTHOR: FAN Qinmin [5400 2953 2404]

ORG: None

TITLE: "Neutrino Communication"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 1, Mar 79 pp 20-21

ABSTRACT: On 26 Jun 78, the Central TV Broadcasting Station in Beijing planned to tape the Eleventh World Soccer Competition between the Argentine team and the Holland team to be held on that day at 2 A.M. Beijing time for the purpose of rebroadcasting later on the same day. The Beijing station had to utilize the International Communications Satellite; the TV signals broadcasted by a ground surface station near Buenos Aires where the game was being held had to be relayed to a communications satellite above the Atlantic Ocean before being relayed to a ground surface station in England, then a communications satellite above the Indian Ocean, then to the ground surface station in Beijing. Is there a more direct way of communicating between the Eastern and the Western Hemispheres? With the development of high energy accelerators and high energy neutrino experiments, a method of long distance communication directly through the earth has begun to be under investigation in recent years. This is neutrino communication. This paper discusses briefly the known facts about neutrinos and the possibility of realizing neutrino communication.

AUTHOR: XU Shaowang [1776 4801 2489]

ORG: None

TITLE: "What Kinds of Work Techniques and Equipment Having Values of Practical Application May be Produced From the Work of High Energy Physics?"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 pp 1-2

ABSTRACT: The construction and development of high energy accelerators are established on a foundation of current science and technology while they also directly or indirectly promote the development and improvement of science and technology. The areas of possible contribution of high energy accelerators to practical applications discussed in the paper include ion source, large scale vacuum devices, electromagnetic technology, superconduction, and low temperature technology. Relationship between high energy accelerators and each of the above fields is briefly explored in separate sections.

AUTHOR: ZHENG Min [6774 3046]

ORG: None

TITLE: "Application of High Energy Probing Device in Other Fields"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 p 3

ABSTRACT: High energy probing device is the eye used to observe and measure microscopic particles and is an indispensable tool of high energy physics experiment. With continued progress in high energy physics experiment, the probing device is required to be continuously improved and renewed in order to obtain more precise results and more accurate experimental data so as to push high energy forward. A series of probing devices that can precisely determine position and have high power of differentiation have thus been developed, and these have also been quickly extended and applied in medium and low energy physics and other basic sciences such as astrophysics, solid physics, nuclear power, medicine, etc. Uses of these new probing devices in these and other fields are briefly explained.

AUTHOR: None

ORG: None

TITLE: "Development of Fast Electronic Instruments"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 p 3

ABSTRACT: In high energy physics experiments, there is a need for measuring high energy particles regularly; therefore, there is a demand for large quantities of fast pulse electronic circuits to make equipment of measurement. This demand has pushed and promoted millimicrosecond electronic technology and corresponding materials, components, and devices. At present, the scale of high energy experiment is extremely gigantic and the large scale utilization in the field of high energy experiment has promoted commercial production of fast electronic instruments. Although these instruments, components, and materials have extensive applications in other fields, it remains mainly high energy physics that promotes their continuous advancement. The data obtained in physics experiment must be treated by electronic circuits,the NIM series before they can be understood by computers. Scientists of the world have reached an agreement to adopt the CAMAC series which is commonly used in high energy physics so that the plug-in units may be applicable and interchangeable in the laboratories of different countries of the world. In this manner, the CAMAC series have been continuously studied, manufactured, and produced, and correspondingly they are also being applied in industries, national defense, medicine, and scientific research.

AUTHOR: None

ORG: None

TITLE: "Application of Electronic Computer 'On Line' Experiment Technology in Medicine"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 p 4

ABSTRACT: In the previous issue of GAONENG WULI the technique of treating the data obtained by probing instruments with the electronic instrument NIM series for delivery to an outlet of the computer, the CAMAC series before being sent to small computers so that the computer may proceed with automatic control on the one hand and on the other hand the data may be sorted, analysed, and computed at once for small scale experiments to produce results instantly. The results of experiment are generally recorded on magnetic tapes and at the same time they may also be displayed as graphs, equations, and curves on the fluorescent screen. This is called the computer 'on line' experiment technology, which has been generally applied in the past decade in high energy physics experiments. This 'on line' technology has also been quickly applied in some famous hospitals and clinics of the world. The medical applications of the computer on-line technology is briefly explained.

AUTHOR: XIE Jialin [6200 1367 7782]

ORG: None

TITLE: "A General Discussion of Design Ideas of High Energy Accelerators(II)"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 pp 18-20

ABSTRACT: An accelerator is composed of many systems and branch systems. It is a unified body with a strict commanding function. In the process of contemplating the different formulae for selecting the systems and branch systems, it is necessary to consider their mutual coordination and problems relating to the harmonious completion of the general project. On the basis of the structure of an accelerator and such conditions as manpower, material availability, and financial resources, this paper continuous to discuss problems of balancing simplicity with completeness, coordinating the level of advancement of related systems, following precedence versus creating new ones, and building a foundation versus staying active.

AUTHOR: ZHANG Baoxiang [1728 0202 5980]

ORG: None

TITLE: "

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 2, Jun 79 front cover

ABSTRACT: The front cover of this issue is a photo taken by the author depicting the linkage system CAMAC made by the Department of Experimental Physics of the Institute of High Energy Physics Research according to international standards.

AUTHOR: LU Haofa [4151 7729 4761-7569]

ORG: None

TITLE: "Possible Large Scale Effects of High Energy Particle Physics on Social Practices of Mankind"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 3, Sep 79 pp 1-2

ABSTRACT: Early in the century, [Ernest] Rutherford predicted that accelerators will not contribute to large scale utilization of nuclear energy judging from the power consumption of the accelerator itself and the dissipation of heat within the target. In view of the condition of the field today, his views may just have been too one-sided. Investigation into economically feasible controlled thermonuclear fusion has been carried on in many parts of the world for close to 30 years and success is still not in sight. The pathway of high energy heavy-ion beam may be the most possible to succeed. Another pathway for releasing nuclear energy is cold nuclear fusion. The question is whether or not quark can be catalyzed into cold nuclear fusion. It is the opinion of the author that these are not just idle imaginaries and breakthroughs in high energy physics will change the appearance of societies. Their impact on the social practice of mankind will exceed the invention of nuclear reactors caused by works on neutron physics in the 1940's.

AUTHOR: LIN Zongtang [2651 1350 2768]

ORG: None

TITLE: "Using All Possible Means to Study High Energy Physics So as to Carry on the Wishes of Chairman MAO and Premier ZHOU"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 3, Sep 79 pp 3-4

ABSTRACT: The author claims that although he does not understand high energy physics or high energy accelerators he has been asked by the organization to participate [without mentioning his capacity of participation in the paper] in this engineering work. Chairman MAO began to be interested in the subject of basic particles as early as 1955. Premier ZHOU personally inspected and approved the blueprint of China's development of high energy physics on his deathbed, but the project was obstructed by the gang of four. In Aug last year, 5 hundred Chinese scientists and technologists toured the United States and Europe to inspect foreign establishments and carried out repeated research upon their return. Four months afterwards, China's first design of a 5 billion electron volt proton synchrotron was produced. At present, under the condition of national economic readjustment, the central party has decided to retain the item of high energy physics research, regardless.

AUTHOR: HE Zuoxiu [0149 4373 1652]

ORG: None

TITLE: "A General Discussion on Particle Theory"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 3, Sep 79 pp 5-7

ABSTRACT: Of all the complex and colorful subjects of physics, particle physics may be considered to be the realm of the most sustained interest. Judging from its development in the past decade the most noticeable occurrence is the idea that all particles participating in strong interactions are composed of basic stratons or quarks. The quark model or the straton model can explain the various observed phenomena very well. Some comrades may suspect that the research into the general unity of things is in fact searching for the terminal truth of the final stage and this search is contrary to dialectics. The author quotes from ENGELS to defend the construction of a theory which unifies the material world. He admits that this unity theory will continue to develop and the completion of certain type of unity will not cause theory to come to rest [forever.]

AUTHOR: ZHANG Zongye [1728 1350 8763]

ORG: None

TITLE: "Prospects of High Energy Nuclear Physics Research"

SOURCE: Beijing GAONENG WULI [HIGH ENERGY PHYSICS] in Chinese No 3, Sep 79 pp 10-11

ABSTRACT: Using high energy particles, including protons, heavy-ions, electrons, and photons, or using secondary particle beams induced by high energy particles, such as π meson, k meson, and antiproton, etc. as the bomb to bombard the atomic nucleus and through the bombardment action on the nucleus to study the composition and structure of the atomic nucleus, the mechanism of high energy nuclear reaction, the formation of strange nuclei, and the strong and weak interactions among particles are all subjects of high energy nuclear physics, which has become a new cross section science. Many interesting phenomena and activities in this new field all over the world are briefly introduced.

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